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Lectures

upon

the Institutions

of Medicine,

in five Volumes,

by

William Cullen M.D.

Vol. 1<sup>st</sup>

Edinburgh 1768.





Manuscript  
18th  
cent



# Institutions of Medicine

As It is undoubtedly necessary to acquire a general Idea of the Origin, Progress and Revolutions in Physic; I shall, in order to assist the Memory, divide the whole into seven periods. Some persons have thought that the whole of Physic consists in the Imitation of Experience, others call it Reason. The first are called Dogmatists. the Second Empirics. —

- |                        |                                       |
|------------------------|---------------------------------------|
| 1 <sup>st</sup> Period | to Hippocrates who gave Dogmatism.    |
| 2 <sup>d</sup>         | to Serapion the Empiric. —            |
| 3.                     | to Themison the Methodic.             |
| 4.                     | to Galen the restorer of Dogmatism.   |
| 5.                     | to Paracelsus the Chemist.            |
| 6.                     | to Harvey who discovered Circulation. |
| 7.                     | to Boerhaave                          |

Dates of these Periods. —

Hippocrates — 400. Years A.C. — Time of Democritus  
 Serapion — 287. — A.C. — Time of Ptolemy Philadelphus.



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Themison - about the time of Christ - reign of Augustus.  
Galen - 150 years P.L. - Physician to Marcus Aurelius.  
Paracelsus - Charles V. & Luther.  
Harvey - 1628 - Charles 1<sup>st</sup>.  
Boerhaave died in 1738.

## State of Physic in these periods

- 1<sup>st</sup>. Empiric by necessity.
2. Dogmatic.
3. Empiric by profession
4. Methodic set
5. Dogmatic in again, or Peripatetic Dogmatism.
6. Chemical Dogmatism.
7. Mechanical Dogmatism, tho' now on a gen<sup>l</sup>. plan.

1<sup>st</sup> Period - There cannot be possibly any records of the first beginnings of Physic; it must have been as ancient as Man himself, since no period has been free from diseases. - The knowledge gained by Experience would soon get into particular hands, who would both support and promote it - A rude and Savage people are frequently in possession of Efficacious Remedies, as the Instinct of Brutes is often su-

period



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Superiour to the Reason of Man.

We have from a Variety of Reasons, and from his-  
 tory it self, reason to believe that physic first got into  
 the hands of Priests; it was certainly so in Egypt  
 At first the Sick resorted to the Temples, after that  
 the Priests left the Temples, and became Clinical  
 practitioners, a step to which we must impute the  
 great progress Physic made in Greece. We may be  
 pretty certain that these Ancient Physicians would  
 attempt to introduce reasoning into their physic, tho'  
 but little - and the Philosophers of those Days would  
 attempt Physic, tho' on a slender foundation. It  
 was Hippocrates that united the two.

As much as we talk of Hippocrates, it is very  
 little we know of him. He was certainly a very  
 great Man for the Time in which he lived, but it  
 was but in the infancy of Philosophy, and his writings,  
 tho' they contain many useful facts, are in many places  
 frivolous and trifling - however, by his means, a  
 new face was given to Physic, & both his own family  
 and several other celebrated Names cultivated the plan  
 he had so happily laid down.



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Still Anatomy was wanting to Physic - however as this was so well supplied by Erasistratus & Herophilus, that the Dogmatic plan seemed to be in a most Happy way; when Serapion, taking Advantage of the prejudices of his Country-men, said that there was no Occasion for Reasoning in Physic, and so began an Empirical Sect, that has not been rooted out to this Day. —

It has been reduced to three Heads, Observation, History, and Analogy, a plan that promised much and performed little. Dogmatism always has flourished in a Degree, since the prudent Dogmatists employ the whole empiric plan, and add Reasoning to it.

The Empirics have never produced any writer of Credit - no one of them ever attempted any thing towards Method; it was a mere Castle in the Air, puffed away by the Breath of Galen.

But the followers of Empiricism, tho' they ranged themselves under many different Leaders, did not any of them Survive the Times of Galen. —

When Physic was first introduced from Greece to Rome



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Rome, in the time that the Romans had leisure to attend to Medicine, it put on a new face - It was Asclepiades who by his learning and good nature first fixed Physic in this Capital of the World, whence it had almost been expelled by the rough Behaviour of the first Surgeons.

Themison was the man that abridged the system of Asclepiades, which was as he left it a little too Abstruse for the generality. He laid it down that the Diseases of the Body depended on <sup>the state of</sup> the passages, which were sometimes lax, sometimes shut, and at other times shut in one place & relaxed in the other. This was called the Method - It kept its place 150. Years at Rome and has been in a degree imitated in its plan by most future Methodics.

We now come to Cullen, whose circumstances and disposition afforded him the best Education.

Envy at first drove him from Rome, but being called back by Marcus Aurelius, he became as eminent as he deserved. He professed to follow Hippocrates, how far, we know not. Certainly his plan exceeded any yet published, and his rank, his learning and eloquence drove all competitors off the Stage, and his Physic was the



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the only physic we afterwards hear of, both in Greece & Rome.

The Goths & Vandals drove learning & physic with it out of the western World — Constantinople was the only Asylum that remained for the relics of literature

In the 7<sup>th</sup> century a new Religion and Empire arose, at first indeed destructive to learning of all kinds. But afterwards they Borrowed learning and physic with it from the Greeks — from whom they borrowed every thing except some new diseases, new remedies, and they Casually indeed found out Pharmaceutical Chemistry — But as the Arabians extended their conquests they carried what learning they had along with them, and to them, about the 12<sup>th</sup> century, we owe all the learning the western world then enjoyed, — a time then indeed, little fitted, for the Arts, when war and its operations was alone cultivated.

About the Beginning of the 15<sup>th</sup> century, when Europe was fitter for study, the Turks, by taking Constantinople, drove all the remains of Grecian learning into the western world — Printing too was — new discovered, so was America, and the passage by the Cape to the East Indies — These were all spurs to Industry



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Industry; but above all, States had now taken on a fixed form, proper for the Cultivation of the Arts and Sciences. The Greeks & Egyptians beat out the Arabians - This however you will see, would not make any alteration in the Physical Sect.

Chemistry, we have said, was first invented by the Arabians, they used it in the preparations of Medicines; these however were generally so rough, as not to come much into public use. However, Tracts still remaining convince us that Chemistry was still cultivated in private.

Paracelsus, however, with the greatest boldness introduced Chemistry into Physic, with all that precipitancy we might expect from the Man. By his Lures, he soon grew famous enough to be invited to a professors Chair, where his Sense and Impudence united, at last established a Sect that itself up in opposition to Galen, & at last (strange to tell!) overturned that system which had now lasted 1400 Years.

Vesalius about this Time began to cultivate Anatomy, and detected the faults of Galen, and Bacon and Galileo, by overturning Aristotle augmented the Triumph of the Chemists.

Capende



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Gassendi & Des Cartes too by giving a new system. — which joined in with the Chemists, added not a little to the Victory, which the discovery of the Circulation rendered complete.

We now come to the 7<sup>th</sup> period, one so interesting, that it will be almost impossible to give all the particulars — Philosophy always leads the way for physics — Torricelli, Borelli and some others followed Galileo and Bacon Gassendi restored the Epicurean System of Natural Philosophy — Boyle, Wilkins & several other ingenious Men in England founded the Royal Society, which was the first of those numerous ones since established in Europe. — But Newton was the great leader in the Mechanical Branch, as Boyle had been in the Chemical — During this period the Chemists had been continually gaining ground on the Galenists, at length the Doctrines of Acid & Alkali gave them a short and easy System. — But as we said it was discovery of the Circulation that now conquered the Galenists entirely — It might have been expected that Physicians would have immediately begun to study the Mechanical Laws — This — was.



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was not however done before Borelli, whose disciple Bellini worked up a system that over-ran all Europe. What were the Advantages attending this, we shall not pretend to say, but certainly by being friends to Experiment, and observation they must have been friends to true Physics. —

D<sup>r</sup>. Sydenham by Observation alone has given us a work superior to most, & this very work was put in its proper point of View by the Mechanical Physicians, Pitcairn & Boerhaave. —

The Mechanical Physicians as they were at first chiefly opposed by the Chemists, neglected them too much — Boerhaave united the Chemical Doctrines of Acid & Alkali, with Lentor, Obstruction and Viscidity from the Mechanical Physicians, & the Doctrine of Plethora from the Galenists — But still something was wanting, viz<sup>t</sup>. the human body as an Animated System and the Nerves as the organs of that Animation. Van Helmont, Polakus Wapfer, all saw the necessity of this, but nothing of importance was done before Stahl, who thought the body and its motions were governed by a rational soul. —



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The great fault to be laid to them is their feeble practice, but certainly they have studied Diseases in a superior manner to any other School.

Willis & Laver became great anatomists with respect to the brain and Nerves, and Willis gave us a pathology on the Subject. Baglivi followed. Haquet in France was his Disciple, and Hoffman carried the Nervous System to a Height it had never before reached. Hoffman was long of establishing his doctrines, but now Van Swieten, Staaw Boerhaave, Haller and Gaubius the Chief of Boerhaaves Disciples are the strongest advocates for Hoffman's System.

The Body can only be considered as an hydraulic Machine, a Chemical mixt, or an Animated System. So our parts are all complete. In these three views of shall consider the human body in the course of these Lectures.

Redd



# Institutions of Medicines

Medicine is the art of preserving health and curing diseases, and is not only the knowledge of practices purely insitative, but is what knows how to adapt means to an end. —

D<sup>r</sup>. Boerhaave and D<sup>r</sup>. Ludovic have both of them given very good Definitions of Medicines, which you may consult. My Definition only requires the understanding of Health & Disease, both which may be taken in the common Acceptation, or according to the words of D<sup>r</sup>. Boerhaave. —

There are many disputes with respect to the best plan of studying Physic — Some plead for Empiricism, others for Ratiocination — The former indeed is seldom taught simply as such in Schools — It is a question of some nicety, which I shall not enter into here, But I confess I wish that every part of my Course may be thought of Importance. —

The extent of our Art is prodigious 300 Genera, & 3000 Species have already been marked out by Nosologists, not to speak of the prodigious Variety which all deserve a Physician's Notice, all of them should be marked, and at the same time the Medicines that



## Difficulties of an Empiric Plan.

that are adapted to them. Now it is plain that few Empirics could boast an extent of knowledge equal to this, or any thing adequate to it - they therefore had recourse to Analogy, a principle that must in innumerable instances be false & fallacious. —

But the Defects of the Empirics will appear most glaring in the Advantages the Pragmatists enjoy. —

They always endeavour to conduct themselves by imitation and Analogy as far as they are able — but finding these not complete, they are obliged to have recourse to other measures. —

The Assistance they call in is first Anatomy, but this was rejected by the Ancient Empirics — The present Nosologists do not admit the internal seat into the Character of the Disease — certainly however, its use is great, but to be able to inspect diseased Bodies to Advantage, we should be well acquainted with the Anatomy of sound Bodies. Physiology is therefore a step necessarily previous to our making a proper use of the Inspection of diseased Bodies. —

I am of opinion that the use of Hypotheses has had its advantages, in enabling us to collect facts quieter



# Difficulties attending on an Empirical plan

quicker & readier, according to the present mode of Philosophising — The system of Sir Isaac Newton began with an Hypothesis. —

Empirics ancient and Modern have done little; it is the Dogmatists alone that have collected & transmitted the Facts of Physic.

Besides, a Physician attending to the number of diseases, must also take notice of all the powers that can affect or change the human Body, and then compare a prodigious number of particulars — It is true, we have reduced them to a number of heads, but each of these include an immense variety of particulars.

Here we proceed first by imitation, then we proceed to Analogy, which obliges us to study Physiology, both Mechanical and Chemical. —

I now go on to observe that Chemistry has been of very great use in enabling us to distinguish the different efficacy of Medicines, and prepare several powerful ones, which it would be impossible to obtain without it. Besides in several instances, it brings us to a certainty in preparing Medicines, that we by no means possessed before. —

The



# Empiric obliged to make use of Reasoning

The Empiric in discovering the Virtues of Medicines must either make random trials, or proceed on analogy — which will, I am sure, lead him, (if he follows it to any Advantage) to trace Diseases from their proximate Cause, and Medicines from their Rationale. —

Thus we see that the Empiric slides by degrees into Dogmatism, and I never yet knew a Physician that could avoid Reasoning — A man therefore out of prudence will study Theory, to guard against his own Errors, & those of any body else. —

Besides, it is almost impossible for a young Physician to learn physic from an empirical plan; let any one on this head but compare Lieutaud and Boerhaave. —

But there still is a question to be considered, How far we are to study Dogmatism? The answer will be that we must study the whole, as all the parts depend the one upon the other — most of the parts too are capable of use, and even those parts that are not so to appearance, may by the slightest Circumstance become so. —

I have now said all I shall in Recommendation of a  
Dogmatism



# Dogmatism preferable to Empiricism 15

Dogmatical plan, we take all the Empiricism, we endeavour to add something to it, and at worst we shall never fall lower than the Empiric. —

Upon this plan physic is taught here, and is divided into Institutions & Practice — In the latter ~~exercises~~ the Professor considers first the appearance of the Disease, the state of the Body under it under the operation of Remote causes, after that he compares the sound state of the Body with the Morbid and then draws the Indications of Cure, and after that adapts Remedies — But in order to understand this — there are a great many heads of general Doctrine — which it would be tedious for a Professor to repeat, & this falls to the share of the Professor of the Institutions — This has been called the Theory of Medicine — but I think improperly — For even the Empirics would have a collection of general facts and Analogies, and I shall give both Dogmatical & Empirical instructions.

A person to attend this class to advantage, should understand pretty decently the Languages, Natural Philosophy, Chemistry, Botany and Anatomy —

with



# Books to be Read.

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With regard to Books, I know but two, that I should recommend — Haller's Physiology, and Gaubius's Pathology — the first is the best book of the kind — the Anatomy of the parts excellent and the Physiology, at least the most common.

As to the Element: Physics of Haller, they are only proper for those that have made some advances.



# Institutions of Medicine

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The State of the Body in Health, is necessary to be considered — its Functions, Economy &c. —

2<sup>dly</sup> The several Deviations this System is capable of undergoing — What these are, when particular Diseases occur — hence are formed what is called an Indication. i.e. in what particular circumstances the Change consists; and this naturally leads us to consider what is necessary to bring back these parts to their Natural State. — From these circumstances we are led to divide the Subject into three Heads. —

1. The Doctrine of Health, or Physiology, which includes the functions of the Body — the manner of performing these &c.

2. The Doctrine of Diseases or Pathology — This includes the proximate causes of Diseases, and the several remote causes which can effect this, especially in the Sanguiferous System. —

3. Contains the Doctrine of Means, by which Health is to be preserved, or restored when lost — This is called in our System The Remedies Therapeutic or Methodus Medendi. —

Long



Long ago another Method prevailed of dividing the institutions into 3 parts — The 4<sup>th</sup> was called *Semeiotica*, which treats of the signs of Health & Sickness — This is no other than the Doctrine of Symptoms, hence a part of Pathology — if this doctrine applies to particular Diseases, we can make no use of it till we come to the Practice. — a 5<sup>th</sup> was the *Hygieina*, which relates to the preservation of Health — This seems to be necessary, but it chiefly turns on ~~the~~ Avoiding the Causes of Diseases — hence we shall either have it in the Pathology, or in the Doctrine of Means. —

It is necessary that these three heads should be kept separate — yet it is almost impossible, if not improper to do so entirely — It is often necessary to join the Physiological and pathological parts together — The Physiology will always be better attended to when carried on together with the Pathology — Several parts of the Pathology will unite readily with the Therapeutica. —

The Doctrine of Causes of Diseases, and the Remedies often appear to be the same. —

1.<sup>st</sup> Physiology as the human Species stands naturally resolves it self into two heads. —



1<sup>st</sup> The Functions proper to both sexes. —

2<sup>d</sup> Peculiarities of the sexes. —

We shall take first the Functions common to both sexes. — The plan of these, in different times, has been very various — it is only thro' time that we come to a view of the whole system — still there are difficulties remaining. The functions of the Animal Economy seem to turn in a circle. We shall however endeavour to premise these things, which are necessary to understand these that are to follow — It might be here said that it would be most proper to give first the Causes & then the Effects. But still the Difficulty returns; for most are mutually Causes and Effects, and most related to each other — hence it is difficult to say which ought to be first. —

I propose to give a general view of the Animal Economy, the connection & relation of its principal parts; and first the several evident motions of its parts — of these there are a great variety in different parts. — The external motion depends on the action of Muscles, but this external motion is not spontaneous, it depends on the action of some other powers. The greatest



greatest part of the Muscles are subject to the power of the will - Nerves proceed from these to the Brain - if these are cut, the power of the will is entirely lost. For any motion, the presence of the Nerves is absolutely necessary - The Muscles and Nerves have a connection; - hence too, there is a connection by means of the Nerves between the Muscles and Brain - Certain applications to distant parts of the Body, will in particular persons, occasion motion in all the parts - as for instance, Musk to the Nose (only) of some people -

Nerves proceed from hence to the Brain - if these are cut thro', the Musk will have no effect - Hence nerves in different parts of the Body excite motion - this is only in consequence of their common Union with the Brain - or in consequence of the Nervous System -

This then is a very principal part of the Animal Economy - The power of the will can only be excited by external Objects &c

The Nervous system or Brain may be hence considered as a very fundamental part of the Animal Economy, and we might presume we should begin here; but if we look farther into the Animal Economy



-ing, we shall find certain hollow Tubes, fitted to carry  
 fluids from one part to the other. The Exercises of the  
 Functions, as dependent on the Nervous System, depend  
 also on the distribution of these fluids - The Functions  
 of the Brain are also interrupted, if the fluids are hin-  
 -dered from circulating there - The chief instrument  
 for this purpose is the Action of the Heart; But we  
 find the Heart to be a Muscle equally dependent on  
 the Brain with any of the others in the Body, and there-  
 -fore Arranges in the same train of Causes & Effects -  
 with the other Muscles - hence also dependent on the  
 Brain - and it is for this reason that we must assume  
 the one in preference to the other - If we look back very  
 early into the Animal Economy, we find the Action of the  
 Heart very soon, but the Brain must have existed be-  
 -fore to give it motion - Again the heart may cease mo-  
 -tion for a time, and be again restored by substances which  
 act on the Nervous system - Hence the nervous must  
 be the fundamental part of our System.

Then comes the distribution of the Fluids - these are to  
 be all explained on the principle of Hydraulics - Hence  
 this part is called the Hydraulic System -

There



There are also other considerable Systems which have—  
pretensions to be considered as fundamental — The Nervous &  
Hydraulic Systems depend on certain organs which will  
be different as the Matter in them is altered, or changed,  
— The human Body acquires a prodigious Addition  
of Matter from its first formation, till it arrives at its  
full Growth — The greatest part of this is acquired from  
the Matters constantly taken in as food — Even when  
the body is arrived at its full Growth, it is not a moment  
steady and of the same kind — Always flying away or  
sent off from the Body — hence a constant supply of  
Aliment is necessary to supply the waste — But the  
Matter of the Aliment and of the Body are consider—  
ably different — hence it is necessary that the Body  
prepares its own Materials, and converts them into  
Matters similar to itself. — Here we must be guided  
by the Doctrines of Chemistry — Hence the Functions  
belonging to this head make the Chemical functions —  
This every where depends on Distribution of fluids  
& the several motions which are performed in the  
System — Hence the Nervous comes first — These three  
have been pursued in a different manner. — Boerhaave  
began



began with the Chemical — Haller finding this depend-  
-ed on the Sanguiferous, began with it; but I for the  
reasons above advanced, begin with the Nervous — We  
must first take a view of the different Materials of which  
the Body is composed — The Solids give the form and fi-  
-gure to the various Organs we meet with in the  
System. —



Of the  
Simple Solids



# Of the Simple Solids



# Of the Simple Solids

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The Term Solid is taken in two Senses;

1<sup>st</sup> Simple, in opposition to the more Compound. Thus Physiologists have supposed the largest Mass we distinguish in our Body to be chiefly a congeries of Vessels; the larger of which they suppose to be formed of other smaller Vessels; and thus proceed to the ultimate or smallest Vessels, whose Sides they suppose formed of a Membrane convoluted into a cone or cylinder, & this Membrane they imagine to be composed of Fibres. These Fibres are called Ultimate Fibres or Simple Solids in opposition to all the other Parts which are supposed to be composed of them.

2<sup>d</sup>. The most part of our Solid Matter is possessed of the general properties of Cohesion, Flexibility, & Elasticity, in common with the Solid Matter in the other parts of Nature; but, at the same time, it is observed that there is a portion of Animal Solids having Properties peculiar to itself only in the living Animal; whereas all the others except this are to be found both in the living, & dead, Animal. These Properties have been called the Vital Property



# Of the Simple Solids

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Property or Power; and that part of the Solids possessed of it is called by *Lantius Solidum Vivum*, & are the *Fibres* *Motorices* of *Baglivi*.

Our Doctrine concerning the Simple Solids shall be referred to 4 Heads;

1<sup>st</sup>. We shall inquire into the different Appearances & Forms of Solid Matter in Animal Bodies.

2<sup>d</sup>. We shall consider the Functions of this Solid Matter, the conditions by which it becomes useful in the Animal System, & the particular degrees of Cohesion, Flexibility, & Elasticity.

3<sup>d</sup>. We shall inquire into the different States of this Solid at different periods of Life, & in different conditions of the Body, in order to ascertain the causes that give these different conditions of the Solids, & to determine more precisely what is the condition in Health & the deviation in Disease.

4<sup>th</sup>. I shall endeavour to sum up our views with regard to the diseased states of the Simple Solids; hence it will  
be



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be necessary to unite Pathology & Physiology, which I observed to you it would often be of use to do.

1.<sup>st</sup> Then we are to consider the different appearances & forms of Solid Matter in Animal Bodies.

It is pretty obvious that the most general & universal form in which we find this Solid is Cellular Texture. A more precise notion of it I leave to Anatomists. The modern Anatomists, particularly Haller, seem inclined to suppose it as forming the whole of the Human Solid. See Haller's 22 Parag: towards the end, & several other places of his Marks. With regard to this it must be allowed that the greatest part of the soft Solids is evidently cellular Membrane, consisting of small Plates interlaid in such a manner as to form a hollow or spongy Mass, which is of a considerable Extent.

There are now two portions of the Animal Solid that we can distinguish from each other but are connected to each other by cellular Texture. It is also as certain that in a more compact State it forms the chief, if not the whole, of what is called Membrane.



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brane. At the same time if it be allowed that all the several vessels of the Body are formed of such Membranes convoluted into a hollow Cone or Cylinder, you must immediately perceive what a considerable part of the Body is to be considered as Cellular Texture.

Anatomists go farther, and, as the Cartilages & hardest Bones are in their first appearance in a Membranous State, they conclude, both from Analogy & Experiment, that these are equally a Cellular Texture as the foregoing, having only a substance poured into their Cells, which hardening gives them the appearance of Cartilages & Bones.

Upon this Supposition we might proceed upon our present business; but there is in general nothing so necessary as a caution with regard to forming any general Proposition <sup>th</sup>/<sub>w</sub> respect to an Animal Body. Let us take care therefore in the present case to consider that we cannot make it a general Proposition, for it is much to be doubted if the Nails, Hair, Horn, Hoofs, of Animals were ever in the state of Cellular Substance. I think it sufficiently manifest that they were not, & therefore <sup>we</sup>



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we should take care how we pronounce that Animal Growth is made wholly by Cellular Texture; for tho' it may be a general, it is not an absolute, Proposition. I think it is not so universal in the Animal Body as intirely to exclude a Fibrous Substance.

A Fibre is a portion of Matter drawn out to a sensible length, and of a slender thickness in proportion to its length.

In the first place I will observe that the opinion of a Cellular Texture, in exclusion of a Fibrous, may be admitted in opposition of the Notion of the whole fundamental Parts of the Body being fibrous; which Opinion it is now agreed on is intirely false: But while we refuse this we also say that the Notion of a Cellular Texture as every where found must not neither be admitted; & upon this consideration: First no one can refuse the appearance & Existence of the fibrous Structure in many parts of the Body, particularly in the Muscles, Tendons, & Ligaments; and, (tho' not so evident) in the principal Membranes, as the Dura Mater, Pleura, & Peritonæum.

To disprove this, the Anatomists, who are Advocates for



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a cellular Texture, say that an apparently firm Membrane, if blown up, shews the appearance of cellular Texture, or else by Maceration in Water puts on this Form without any remaining appearance of fibrous Structure. This is their Argument for asserting that the apparent fibrous Structure is at bottom a cellular one. The Experiment however I say is not conclusive. One of these Anatomists has performed his Experiments on the Coats of the Aorta, and finds it all resolved into a cellular Texture; but the Muscular structure of the Aorta shews that a fibrous Texture exists there, & consequently that the Experiment goes too far, & destroys the tender fibrous Texture.

Dr. Haller & others cannot deny the appearance of a fibrous Texture in many parts of the Body; but say that this is originally formed of cellular Texture: how far this is this is  $\frac{2}{3}$  & case we must inquire in another Manner.

I say that the Medullary Substance of the Brain is under a fibrous Arrangement or Texture, which is at present very generally agreed, and that the Nerves are a continuation



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ation of the same Fibres having them more accurately distinguished from each other, & thus distributed to every minute part of the Animal Body. Now in applying this I will assume the Hypothesis of Haller, that the formation of all Bodies depends on preexistent Germs, Stamina, or Rudiments, delineated & formed by God. Now we will readily admit the Nervous System to be these very original Stamina; which is proved from the necessity of its previous existence to any other part, & from many of the Phenomena of Nutrition, which presume that the whole After-growth or Nutrition is carried on by that primitive Nervous System: whence it follows that the Body in its primitive form is of a fibrous Texture, & we readily allow that all the After-acception of Bulk is chiefly made in the form of Cellular Texture; which, according to the different circumstances it undergoes of Accretion, Pressure, Extension, & having its Interstices filled <sup>th</sup> with a solid Matter, forms the densest solid parts of the Body, therefore the foundation of the Body is in a fibrous Structure or in a Nervous Fibre.

The



# Of the Simple Solids

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The application of this at present is only to consider a new refinement on Simple Solid by Monf.<sup>r</sup> Bourdeau. He maintains that there are Fibres distinct from the cellular Texture, but that they are all of one kind only in all different Animals, that they are the same in number in all Individuals, of all the different Species, and the same in size & consistence in all Ages, Sexes, & Temperaments, in the same Species. He maintains that this fibrous part is of a steady nature & immutable by any power of our System but what destroys its Substance; & therefore that all the language of the Schools with regard to Rigidity, Laxity, Debility of the Fibres &c. is all imaginary, & that these affections are to be considered as changes in the cellular Texture.

I must however say that Monf.<sup>r</sup> de Bourdeau's doctrine is not to be freely admitted; for, in the first place, his Ideas & Facts are entirely assumed from the consideration of Muscular Fibres; & his Authorities are only the Microscopical Observations of Leuwenhoek; but his accounts are so variable, unsteady, & even contradictory, that I am unwilling any Conclusion should be drawn from them with regard



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gard to the ultimate fibres of Muscles. However the later Observations of Mons. Musse seem to make the same conclusions; viz that the Muscular Fibres are uniform in all the different Bodies that were examined: but Mr. Musse's smallest Fibre is to the breadth of a Hair as 27,000 to 1, & how readily one may be deceived in measuring this you may easily judge & that the Observations cannot be very accurate. I could further alledge that a later more accurate observer seems to point them out as of different sizes. From these & several other considerations the Doctrine I think is not to be admitted, tho' I allow that these ultimate Fibres are less liable to change than other parts of the Body, & we have this proof of it that the Nerves attain their full growth much sooner than the other Parts of the Body: but it is difficult to say that they admit of no increase, for every part of the body is augmented in bulk by the constant application of Nutritious Matter to them, so that I maintain the Nervous Fibre is to be considered not a Simple Solid & yet suffering some alteration in the progress of Life; but, however this refinement may be, it cannot have any



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33.

any influence upon the present Doctrine, & it will be very much the same whether the Functions are to be considered as depending on Simple Fibre or cellular Texture, & we shall take care that every thing we say of Simple Fibre is applicable to Simple Solid in the form of cellular Texture.

II. Having therefore thus settled this Subject we now come to the 2<sup>d</sup> Head, which was to consider the functions of this solid Matter, the conditions by which it becomes useful in the Animal System, & its particular degree of Cohesion, Flexibility, & Elasticity.

Its first property is that which constitutes it a Solid, that is a certain force of Cohesion. It is thus distinguished from a fluid, whose Parts are moveable upon, & separable from, one another by the smallest force, whereas the parts of a Solid are not moveable upon, nor separable from, one another without a much greater force: tho' indeed there are no certain limits here, but all the intermediate degrees between fluidity & Solidity. A certain force of Cohesion alone can give a consistent Figure.



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Figure, for a fluid has no consistent Figure but in as far as it is confined by Solids. The Animal Body therefore necessarily requires a certain quantity of Solids to preserve its form by confining the several Fluids. The degree of Cohesion is only to be determined relatively; for it is different in different parts, & at different Periods.

The Cohesion of solid Bodies is of two different kinds, distinguished by the appellations *Soft & Hard*. Soft & hard Bodies differ in their more or less admitting the motion of the Parts upon one another without a total Separation of them from the whole Mass. In how many Degrees this may be considered is not necessary to take notice of at present.

Soft Bodies are of two kinds;

1<sup>st</sup> Flaccid.

2<sup>d</sup> Elastic.

The Flaccid are such as admit of the motion of the parts to a considerable extent without separation, & remain in the Situation they are put into by the external Force.

Elastic



Elastic are such as admit of a similar Motion of the Parts, without separation; but, upon the external Force being taken away, & parts return again into their former Situation.

Most, if not all, of the soft parts of Animals are at the same time flexible & elastic, & you will presently perceive that the Economy requires this with regard to almost every flexible particle in the human Body; for there is scarce a Motion performed but some part is stretched. This condition is especially necessary in the Vessels that they should stretch to accommodate themselves to the fluids poured in, & since these fluids are to be propelled forwards, they must necessarily lessen themselves to be accommodated to the quantity of fluid now in them which is decreased.

These are the chief properties of Simple Solid, & we shall now see how they apply to its Functions.

We are in the first place however to inquire into the causes of these properties being in different degrees, & afterwards the causes that give occasion to health & disease of Simple Solid. It is evident we might proceed directly to inquire into <sup>the</sup> causes



causes of these properties; but, if we can first understand the causes of them in Matter in general, we shall be more able to explain them in Animal Solid; which, however difficult, I am inclined to attempt.

From the view of what happens in Elastic bodies we must perceive that any Chord or Fibre cannot be stretched out in length without the several parts being drawn to a greater distance from one another than before; and, as, upon such stretching power being removed, the particles return to the same contiguity as before, there must be a power to bring them back again; and this appears to be the same power that keeps them in Cohesion when they are brought together; which Power has been commonly called the attraction of Cohesion. Since that term was started we have for the most part been satisfied with the Name, tho' it be only a term for a fact without giving any Idea how it acts. S.<sup>r</sup> Isaac Newton himself has gone a great length in attempting to ascertain how it acts. I am now going to give you my Idea concerning it; but observe I only propose it as an Hypothesis to



# Hypothesis for Cohesion.

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to be tried by Observation & Experiment, & till this is done it is not to be applied: which Method I could shew you is admitted by the greatest Philosophers.

In the first place I suppose that the whole Matter of the Universe may be considered as of two general kinds;

1<sup>st</sup> Atoms.

2<sup>d</sup> Aether.

Atoms are certain absolutely solid Parts of Matter of such minuteness as to make any further division impossible, & consequently unchangeable by any powers of the System, endued with no active power, but possessed of the Vis Inertiae. — These are the Particles on which seemingly the gravity of bodies depends.

Aether on the other hand is a subtle elastic Fluid, and hence having a tendency to motion, each of its particles endeavouring to recede from each other.

In the next place I suppose these two kinds of Matter are somehow connected together in such a Manner that every single Atom has a portion of Aether connected with it, & surrounding



Fig 1.<sup>st</sup>

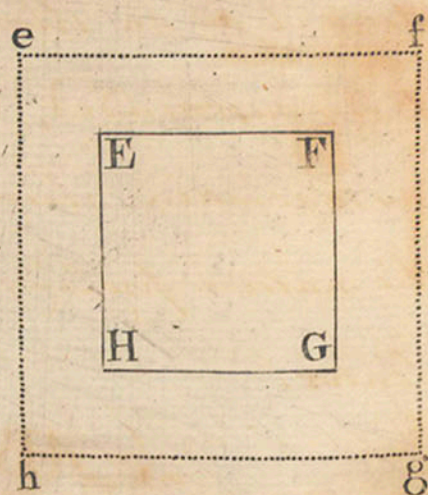
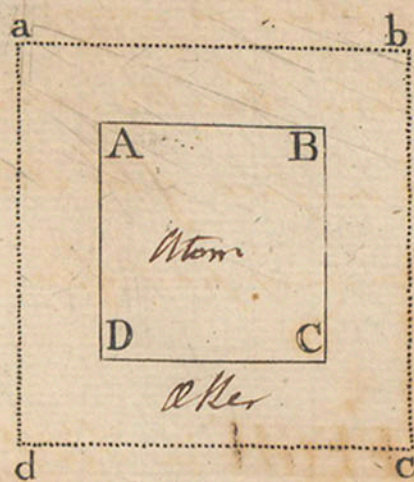


Fig. 2.<sup>d</sup>

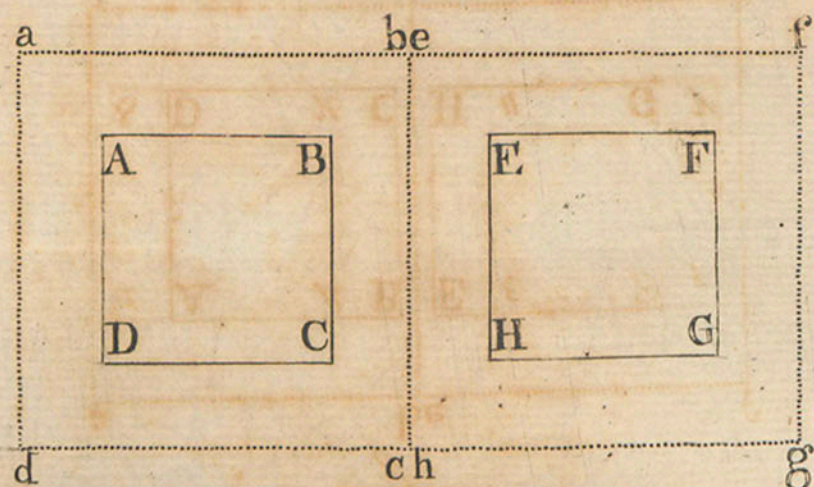
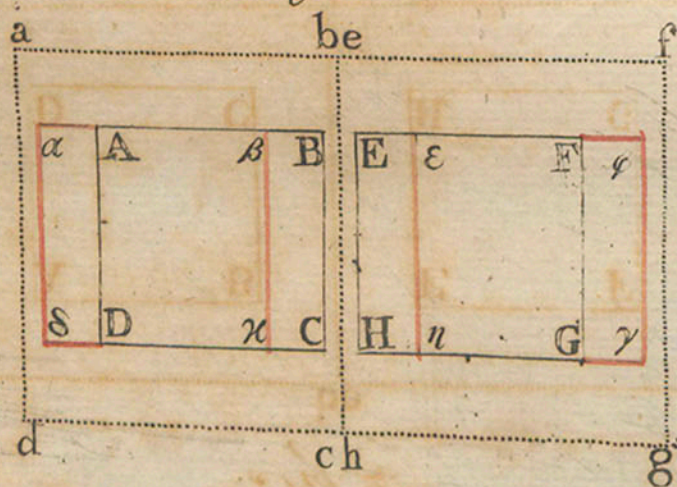


Fig. 3.<sup>d</sup>





# Hypothesis for Cohesion.

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ding it as an Atmosphere, which is always of the figure of  $\frac{1}{2}$  Body surrounded, & of a certain limited extent, & so connected as to remain always on the surface of the Atom, & by its Elastic nature pressing equally on every part of the Atom towards its Center.

Let ABCD and EFGH in Fig 1<sup>st</sup> (See Table) represent two such Atoms; ~~the~~ the Atmosphere of ~~the~~ <sup>will</sup> be represented by the prick'd Lines *abcd* & *efgh*.

In Fig. 2<sup>d</sup>, I suppose these two Atoms brought near to each other but still so as to leave the Atmospheres of the natural extent, only so as the bounds of the Atmosphere *bc* & *eh* touch one another. In this situation I say no motion of the Bodies will ensue, but, if brought a little nearer, they will repel each other, giving some degree of resistance to a nearer approach.

In Fig: 3. I suppose the Particles to be brought nearer to each other so as that the limits of the Atmosphere are not of the natural extent; it is the effect of that contiguity to diminish the elasticity of the intercepted Ether while it remains in <sup>the</sup> tire



# Hypothesis for Cohesion

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x tire in the other free Spaces. The Aether between BC & EH is supposed to have lost much of its Elasticity, & the Elasticity of the Aether on the outside remaining, we see the reason why Bodies, once brought into a near Situation, should rush together and be united. In Fig. 3 I have not placed the Atoms in perfect actual contact, for none of the parts of Bodies as far as our observations reach are so near each other as not to admit of a still closer approach by the power of Aether. There are therefore some limits to the approach of Bodies. Haller has in my Opinion mistaken this in some Cases (See Par. 395.) We must therefore suppose our Atoms under some limits in this respect, & also, what is more necessary, that under a certain contact there is some balance between the intercepted Aether & that without.

This I think is the state of Elastic Bodies, & I think all that is necessary to explain their Phenomena are the suppositions I have now made. For the bodies in the Situation Fig. 3 will cohere together, & will also suffer themselves by external Force to be removed to a certain distance & yet cohere till the Atmosphere  
acquires



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acquires its full extent as in the situation of the bodies  $\alpha$  B  $\gamma$   $\delta$  and  $\epsilon$   $\phi$   $\gamma$   $\eta$ , which brings them back to the position Fig. 2; when the Elasticity of the Aether on all sides being equal the Cohesion is dissolved.

When you divide a body, force must be applied to separate the particles, & you perceive some resistance as you divide it further & further, till coming to a certain degree the particles are restored to their Elasticity & recede from one another. These Phenomena may be perceived in dividing a globule of Quicksilver with the point of a Needle.

When an Elastic Body is stretched the particles cannot recede from one another without some condensation of the external Aether; but, the more we condense it, the more elastic it becomes; and therefore the force of Cohesion must be increased near the point of breaking, wherefore within certain limits the force of Cohesion increases with the distance; a doctrine contrary to the received maxims of the Schools of Philosophy; but there has not been a supposition made that explains all the Phenomena as well as this. I do not mean to say here that I can render  
the



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the doctrine compleat or obviate the difficulties that may attend it; but I say for the most part it is sound. For, first, it is not intirely an Hypothesis of my own Imagination; for I think I can cover myself with the Authority of the greatest Philosopher that ever lived S.<sup>r</sup> Isaac Newton. He speaks of such a subtle Aether at the end of his Principia and has carried the Matter a good deal further in the queries at the end of his Optics, & even finds an experimental proof of the existence of such a fluid. From several circumstances he has I think proved the existence of such an Aether, but, agreeable to his caution & discretion, bringing out things only by degrees & leaving them to be brought out to their full perfection by after-experiments & observations. He at length insinuates with other applications of it that it occasions the attraction of Cohesion. It is not my business to prosecute it further how well it will apply to the different Circumstances of Bodies, as Solid & Fluid, how well it applies to the Phenomena of Elective Attractions, & to the Chemical actions of Bodies upon  
one



\* I have said that all elastic Bodies shew there is a power of Contractility. Upon this subject I hinted that I shall after have occasion to propose that there is in the Solidum Vivum of Animals a peculiar contractility different from that of any other Bodies. I was therefore proceeding on the opinion that the contraction of the Solidum Vivum is different from that of Simple Solid, which was on the same footing as the contraction of other Bodies.

Haller however insinuates that there is a peculiar contractility in the Simple Solid different both from the contraction of common elastic Bodies & from the Vis Innata of Muscular Fibres. (See Page 443 of his 4<sup>th</sup> Vol. & though less distinctly, Parag. 392 of his Prima Linea) but if any one will make ~~the~~ proper Allowance for the heat, humidity, & degree of Tension, in living Animals, they will easily see that the contractility of the Simple Solid is no farther different than these circumstances would make in any other elastic Bodies: besides, he really ascribes some properties to Simple Solid which properly belong to Solidum Vivum; as in the same place of the Prima Linea.

There must be some mistake there in his supposing the Contractive



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one another.

Having thus endeavoured to give some account of the causes of the properties of Elasticity & Cohesion in Bodies, we will now consider the causes of the different conditions these properties may be in Animal Solids; and in the first place it will occur that the general cause is every where modified by the nature of the body, or its being a Mixture of a particular kind; thus the Vitriolic Acid, joined to Magnesia, forms a tender friable Salt; but, with a Calcareous Earth, it forms a Selenites, a Gypsum, or Alabaster, of a much harder or firmer consistence. The difference therefore in the cohesion of these Substances depends on the nature of the Ingredients the peculiar mode of concretion; wherefore, force of cohesion, degree of flexibility & elasticity, depend on the matter on which the body is formed, & this gives the proximate cause of its particular state: whatever influences it are the remote causes.\*

Now with regard to the concretion of Animal Substance considered as an Aggregate. Any body considered as a single



traction of the Skin from cold or terror to proceed from the Simple  
Solid. The Skin indeed has no muscular fibres, but is every  
where a texture of the extremities of Arterious Vessels which  
are endued with Muscular Fibres & are very sensible. If you  
consider all this I think you will with me maintain that there  
is no peculiar contractility in the simple Solid different from  
any other Elastic.



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single individual Mixture, the parts being so small as to escape our Eyesight, is called an Aggregate. They are of two kinds;

1<sup>st</sup> Homogeneous.

2<sup>d</sup> Heterogeneous.

The first is where the smallest parts are all of the same nature & qualities. That cohesion of Aggregates called Homogeneous is where every individual particle is precisely of the same nature with every other, & the cohesion of the whole depends on the cohesion of every particle.

The latter is such as we can divide into parts of different natures & qualities; the one holding the other together as by a cement. These are composed of sensibly different Masses of Matter; which, in their sensible, are totally different in their nature one from the other, & when the particles of the one are taken by themselves, they have often no force of Cohesion, but the cohesion of the whole depends on the Cohesion of the other part; such are different parcels of Wood united by



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by Glue, a quantity of Sand united with a Calcareous Earth or Gypsum.

With regard to the nature of Animal Solid the first question that occurs is whether it is to be considered as an Homogeneous or Heterogeneous Aggregate.

The last is the Idea that is commonly entertained, being first started by Boerhaave. He supposed the Body to consist of two different kinds of particles, the one acting as a cement to the other. D.<sup>r</sup> Haller brings out this in his 3, 4, and 5 Parag: I think it a false Idea, & I shall, first, shew the Arguments they bring do not admit of such a conclusion; and, secondly, that there are Experiments which prove the contrary of what they maintain.

The first Experiment hinted at by D.<sup>r</sup> Haller is that if Animal Solid is exposed to the Fire, the greatest part is dissipated in Vapour; but there remains an unchangeable earthy part behind, (not consumable by the Force of Fire) the constant part; which he supposes the Basis of Animal Solids.



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Solids: but these in their present State form a friable incoherent Mass, & do not take on an aggregate form if some Matter, as a Cement, be not interposed between the particles.

The other Experiment is by Putrefaction, which produces the same circumstances.

This is all true in fact, but it does not conclude that, before such Ignition or Putrefaction, these particles lay separately; for no such chemical Analysis does resolve bodies into their component parts, at least they are not in the same form.

A proof of this is that in a thousand Instances we cannot compound the same body of the parts into which it was broken down by Chemical Analysis, & in many cases where we know the composition we find that fire does not reduce them into the same parts. Thus if Cinnabar is treated by chemical Analysis it is not reduced by the Fire into Mercury & Sulphur, but the Sulphur is converted into an Acid & a Vapor that escapes

us.

Mr. Beaumur illustrates this by a Pudding, which is



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is composed of Flour, Butter, Eggs, Sugar, &c: Now as it pleases my taste I am desirous to procure another of the same kind, & am to find out the several component Ingredients by a chemical Analysis. Let me try it by Evaporation, Distillation, or in short any other way, I shall never get any one of the Ingredients except perhaps a little Water.

Chemical Analysis is now therefore upon those accounts given up for discovering the composition of Bodies. There is therefore no proof from this that a portion of Earth lay separate in the composition of Animal Solids.

Again the whole of their reasoning is founded on a very false notion with regard to the qualities of bodies.

It has too often been the practise of Chemistry to seek for <sup>the</sup> qualities of the Compound from those of the several Ingredients, not perceiving that the qualities of bodies proceeded from the combination of their Ingredients, & that the compound possessed qualities different from any one of the Ingredients; of which any one acquainted with Chemistry will suggest a sufficient Number.



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ber of Instances: Thus the Vitriolic Acid, united to the Earth of Magnesia, forms a tender friable Salt; but, with the Calcareous Earth, it produces Selenites one of the firmer productions of Nature; Whence we would be apt to conclude that the Calcareous Earth in its own nature gives Firmness & Solidity to the compound of which it is an Ingredient; but this same Calcareous Earth, joined to the Muriatic Acid, forms what we call Fixed Ammoniac; a substance still more friable than Glauber's Salt. It is therefore improper to seek for the cause of the firm concretions of Animal Solids from a solid Matter contained in their composition. The Earth of Animals is certainly the same with the Earth of Vegetables, which we now know to be the Calcareous Earth. This is composed of a Saline Matter, Lime & Air, both of which are disposed to a fluid form, & the firmness of Marble or the Calcareous Earth proceeds from the combination of these. This therefore cannot be the unchangeable Earth mentioned to be discovered in the chemical Analysis of Animal Solids. We have now got a new Opinion, viz that Earth is not what



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what gives the firmness of Solid, but that Air is the cement of Nature, supported by the Experiments of Hales & Macbride. It is enough to shew that the composition of Animal Bodies by Gluten & Animal Earth is a false Philosophy in every respect, & that no conclusions can be drawn from the calcinations, coctions, & Putrefactions adduced to prove it.

On the other hand, without these proofs we might have presumed the contrary, since, in all the fundamental productions of Nature, there is no instance of heterogeneous Aggregate; but the homogeneous plainly runs through all except some of the larger Concretions.

With regard to Animal Solid every circumstance leads us to suppose it an homogeneous aggregate. It is plainly formed as far as we can perceive of an uniform homogeneous fluid which assumes a solid form by abstraction of part of the fluid. We can plainly observe this in the formation of the Silk in the Silk-worm, & the Spider's web; which are prepared in a fluid form, & merely by exposure to the Air take  
on



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on a solid state. These in no respect differ from other Animal Solid. Likewise, where we find it simple & in its inorganic form, we always find it homogeneous, distinguished by perfect uniformity and equally uniform transparency, which are easily seen in Animal Solid. I am therefore inclined to believe that the whole of Animal Solid is a Gluten, such as they suppose cements the Earth. It is the different circumstances of this in itself that gives the different degrees of flexibility &c; and even those of the contrary opinion are obliged to consider these properties as arising from the Gluten not the Earth.

Animal Solid is a compound body, but unluckily for us we know very little of its composition, at least not so much as to apply it to our present purpose. The vulgar Chemists have indeed assigned the different ingredients of Water, Oil, &c; but I am persuaded we are still ignorant of the distinction that may subsist in elementary parts, & of what different kinds they are. we know nothing of their different proportions & of the circumstances that may occur in their combinations.



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combinations. I can only give this general point of Doctrine that Animal Solid is a composition of several Ingredients, and may vary either by the different proportions of these Ingredients, or, as I may say, by the insinuation of foreign matters into its composition. The changes we may mark as so many facts that very often we cannot assign what difference in the composition gives rise to them; thus in the Scurvy we know the Nutritious Matter is vitiated, but in what manner no one I believe will pretend to determine.

In the Lues Venerea, Cancer, &c, there are foreign matters insinuated into the composition of the Animal Solids & change their nature; but every body knows how far we are from being acquainted with the particular nature of the Cancer, Scrophuli &c. I do not at all exclude the whole of chemical reasoning when we come to know a little more of the Animal composition, but we must at present be extremely cautious.

One case only is applicable to our purpose.

In Animal Solid we can always perceive a considerable quantity of water entering its composition. But by the Extraction



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traction of gluten of Animal Solids we know it can be united with different proportions of Water, & that these different proportions of Water will carry it through most of the changes we have to consider, that is, it will carry it from a fluid to a solid state, & in the intermediate states it is possessed of all the different degrees of Flexibility & Elasticity. All the ordinary States therefore seem to depend on the proportion of Water and other Matter entering the Animal Solids & I hope we shall afterwards find that the remote causes which influence the conditions of our solids will be satisfactorily explained from this Principle.

We have been hitherto only employed in clearing away the rubbish from our foundation: we are now to attempt a structure that may be fitter to remain.

I say that it is in the first place obvious our Solids have Water in their composition & that in various proportions. We find in fact that the most solid Bones have it in considerable quantity, & perhaps the most firm Concretes Nature



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ture presents us with. The more soft parts of our Solids must have it in greater proportion, and this is certain that most of the solid parts were originally in a fluid form. We see that the Animal Body begins from a soft gelatinous fluid Mass & in every part of its progress when we view Nutrition we can only suppose it to be applied ~~to~~ in an extremely fluid form, & that y<sup>e</sup> Animal Economy is furnished with various means whereby a part of that fluid is abstracted while the more solid & firm remains, & that undoubtedly, as this is more exactly & completely formed, a Solid of different consistence & qualities is produced.

I think therefore we may consider Animal Solid as consisting of 2 parts; fluid, & firm.

The 1<sup>st</sup> is in the greatest part ~~part~~ formed of pure Elementary Water. All the other parts that enter into the composition I consider as firm.

I say next that we shall find the Cohesion, Flexibility, & Elasticity, to depend in most cases upon the proportion



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portion of fluid & firm in the composition of the part; & this I think is a principle that is simple in conception and easily applicable. As the fluid is in greater proportion, in proportion is the cohesion less: on the other hand, as the proportion of Water is diminished in the same proportion does the cohesion of the fibre become stronger. But there are bounds here, for a certain proportion of fluid seems absolutely necessary to the cohesion of the most solid part, & if the fluid is abstracted beyond that, the Mass is rendered less cohering & becomes friable. In like manner, with regard to the other property of flexibility, fluids are the most flexible of all bodies, & therefore we may say that every body is more or less flexible in proportion to its degree of fluidity; but when this depends on water the flexibility must be flaccid & void of Elasticity. There is a certain proportion of Water at which Elasticity begins to appear, & increases till the body becomes hard, brittle, & friable; and, as the Elasticity increases, the flexibility constantly diminishes; so that upon the whole these properties will exactly follow the proportion of



The remote causes of the different states of Simple Solid are such as act upon,

I The most Simple Solid.

1. By causes affecting its composition.

A Applied internally by way of Nourishment.

a. The quantity of Aliment.

b. The quality of Aliment.

c. The assimilation of Aliment.

d. The proportion of Aliment retained.

e. The application of Nourishment depending upon,

α. Original Stamina

β. Exercise.

f. Proternatural Matters.

B Applied externally

a Emollients.

b Astringents.

c Various Matter.

2. The Matter given by causes affecting Concretion.

A. Heat & Cold.

B. Pressure.

C. Tension.

D. Motion or Rest.

II. Organized Solid.

1. By Rest.

2. By Pressure.

3. By Concretion.

A. From Collapse or Pressure.

B. From Concretion with stagnant Lymph.

C. From Cicatrize.

4. By Loss of Substance.

5. By Overstretching.

6. By effusion into Cellular Texture.

A. Of Matter remaining fluid.

B. Of Matter hardening.

7. By new Accretion.



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of fluid & firm in the composition of any body.

This is not a mere Hypothesis. I hinted at one Experiment in proof of it, extracting the Gluten which we bring to all these different states by different proportions of fluid; & the extracting the Gluten may be considered as some decomposition of the part, yet it comes the nearest to the Animal Solid of any thing. If it be said however that this does not exactly apply to Animal Fibre we may with a piece of Catgut exhibit all the Phenomena merely by the application of fluid. You will find also that the writers on this subject, though they use some difference in language, yet their meaning is very nearly what I have proposed. (See Gaubius Parag 162 & 166)

The best confirmation of the use of this general doctrine would be our finding its application to explain the operation of remote causes, & for your assistance in this matter I have made out the following table (see Table) which puts under your eye at once the different parts of our doctrine.

The



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The different states of the properties of Simple Solids may in the first place be referred to three heads with regard to the proximate or immediate cause.

1<sup>st</sup> The state of composition or mixture.

2<sup>d</sup> The mixture being given, the state of Concretion.

3<sup>d</sup> The mixture & concretion being given, the properties will be in different states according to the state of the Organization.

By the proximate cause I mean that state & condition of the solid on which its particular Cohesion, Flexibility, & Elasticity, more immediately depend.

One of these heads I have considered fully. The others I reserve till we come to the application of remote or evident causes that may affect the different states of our Solids.

In the Table the remote causes are arranged with a view to the several proximate causes, and are therefore divided into such as act upon the most Simple Solid & such as act upon the Organized Solid, still using the term in opposition on



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on to the *Solidum vivum*. We suppose Cellular Texture composed of Plates & one of these plates by itself we call the most Simple Solid.

The Organized Solid is when for instance several of these plates are laid together so as to form a cavity containing a fluid. A parcel of these laid together form a Membrane, & this again convoluted forms a Vessel; which are still higher degrees of Organization.

The causes which act upon the most Simple Solid are again distributed into two Classes;

1<sup>st</sup> Such as affect its Composition.

2<sup>d</sup>. The Matter given, by causes affecting its concretion.

The circumstances affecting the composition or mixture of our Simple Solid I consider with regard to their application in two views; as applied internally or externally.

We suppose here that Nutrition depends on a particular fluid prepared in the System & distributed by particular



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ticular canals to the several parts of the solid to which it is to be applied. This I consider as internal application, & whatever is in any other way conveyed or insinuated into the Solids I consider as externally applied.

The Substances internally applied act in some measure by changing the condition of the nutritious fluid and affecting its application; for it is certainly applied at first in an extremely fluid form & increases our Solids by augmenting the solid parts & its force & strength of Cohesion; & hence they are stronger and weaker according to the quantity & quality of the Nutriment applied to them. This Nutriment is manifestly derived intirely from the Aliment or what is taken into the body.

Aliments are seemingly of great diversity, but we suppose them much the same in so far as they contain a substance convertible into Nutriment, which may be as to quantity in different proportions in different Substances; but still the proper Alimentary matter we at present must consider as nearly of the same kind. I own there is constantly adhering to the most of  
our



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our Aliments a quantity of Matter not at all convertible into Nutriment; some of which however is carried along with the convertible part, which I consider as preternatural Matter.

The effects of the Aliment depend on the five Conditions expressed in the table; viz the quantity, quality, & Assimilation, of Aliment, the proportion retained, & its application. These five must be commonly taken together. Thus, the other four being given, the nourishment & strength of Simple Solid will be as the quantity of Aliment taken in. The reason is sufficiently evident & the fact well known.

Secondly, all the others being given, the effect of Aliment on the Simple Solid will be as the quality of it. This term may appear improper as I said in the ( ) that it was always of the same kind. But what I mean is that the quantity of Matter convertible into Nutriment is in different substances of different proportions; thus a pound weight of Beef is found to contain more Nutriment than a pound of Bread, & this more than a pound of Spinage, which



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which comes really to much the same thing as in the Section immediately above.

On this subject some difficulty arises from the proportion of Water taken in which may be considered as Nutrient as it enters the composition of our Simple Solid. The Nutrient must therefore be in such a fluid State as to afford this, and indeed the Water must always be in superfluous quantity, & afterwards abstracted by powers for this purpose: for, first, a certain quantity of Water is always necessary for Assimilation, and the larger the quantity, within certain bounds, it is presumed to be the more favourable to that operation. Secondly, we may suppose that a large proportion of Water favours the distribution of the Nutritious fluid, which many facts seem to confirm. Thirdly, we shall perceive that Nutrition is extremely favoured by the extension of our Solids, which gives opportunity for the insinuation of further Nourishment. But a large quantity of Water augments the bulk of the fluids, by which the vessels are stretched & consequently every fibre in the body, the



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question therefore is whether this circumstance may not favour growth & strength. In the breeding of Calves I am told that if two of them are fed with equal quantities of the same Milk, but one of them have a quantity of Water added to the Milk, it will occasion a quicker & more considerable growth of the Animal, & from what has been mentioned we can easily admit the fact. Some will go farther and alledge that Water will compensate a part of the Nutritious Matter. It may be so in fact, but our applying it will be attended with a little uncertainty; for there are limits here: An overproportion of Water may impede assimilation, for with regard to many Aliments this depends much on their being retained a certain time in the Stomach; in proof of which I think we can produce several facts. A large proportion of liquids also hastens excretion, and we can generally say that a quantity of Nutritional Matter passes off along with this.

3<sup>d</sup>ly The Concretion depends on the abstraction of the superfluous Water, & therefore in certain cases the quantity of fluid may be too great in proportion to the abstracting



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abstracting powers, & therefore the quantity of Water adhering will be greater & give a looser & weaker solid. But this Subject still requires further experiment & observation.

The 3<sup>d</sup> Circumstance is Assimilation, by which the others being given the effects of the Aliment will be varied by Assimilation. I mean every change that is made upon our Aliment from the time it is taken into the Mouth till it is secreted into the Nutritious fluid. Even our Animal food may require several of these internal operations more than being merely broke down, but all Vegetables undergo the whole course of Assimilation. It depends partly on Manducation but chiefly on the state of the Stomach & other Chylopoetic Viscera.

Now we are certain that the state of this Function is different at different times & therefore the quantity of Nutritious fluid must consequently vary.

4<sup>th</sup> The other Circumstances being given the quantity of Nutriment applied will be in some measure more or less according to the quantity of Nutritious Matter retained in the



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The System. Thus certain persons take in & digest well a large quantity of Aliment, but no more or perhaps less Nutrition takes place than in others who take in a lesser quantity. In these cases we suppose the Excretion is more prompt & considerable, and this is confirmed by observing that certain Aliments which are less perspirable, as Fish, (particularly Oysters) & the flesh of young Animals, are most nutritious. The application of this however is liable to uncertainty, for in most cases where we perceive this is more ready & considerable Excretion the Ingesta are in greater quantity; & therefore with greater Excretions there may be more Nutrition. It is certain indeed that Persons in this condition are often of thinner habits; but how far this may affect the state of the Simple Solids is very doubtful. It is only in Persons of lax fibres & not increasing in bulk that we can suppose the cause to be too ready & great Excretions.

The next Circumstance is perhaps of more importance than all the rest, viz The application of Nourishment, comprehending whatever relates to the secretion, distribution,



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distribution, as well as the more immediate application, of ~~the~~  
the Nutritious Matter.

~~circumstances depending upon the state of the~~ With regard to all  
of these there may be a variety of circumstances affecting Nutrition,  
but in what they are placed is I think doubtful and therefore  
we must be content to mark the more remote causes.

The 1<sup>st</sup> I have noted is the state of original Sta-  
mina.

It is certain that different Men are of different tempera-  
ments, & that a particular state of solid accompanies these dif-  
ferent temperaments, which runs through the whole of Life to  
distinguish the character of the Economy, & therefore such differ-  
ence must depend on something that is very fundamental in  
the constitution: This is no way more remarkable than in the  
difference of Sex, for very universally the Female is of a more  
lax & weak solid than the Male and accompanied too with dif-  
ferent organization. There is I think no doubt but it must  
be in the original Stamina for we can only account for the  
different Sexes that each depended on preexistent Stamina mo-  
dified



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dicted by God. The Functions of Nutrition are therefore influenced by these.

Shall we go a little further & say that it is probable these first Stamina are the parts of the Nervous System ( ) This with either considerations would make us judge this same Nervous System to be the organ of Nutrition, & therefore the aftergrowth will in a great measure depend upon it, & hence, if this has so much influence upon Nutrition, we must be very cautious of imputing any effects we observe to the other causes.

The whole history of human Life confirms the influence of original Stamina on Nutrition; thus we often find two Men, nourished in every respect much in the same manner, yet one shall be weak & puny while the other is strong & vigorous: This we can only refer to the original Stamina.

The Persons employed in the breeding of Animals know very well the influence of certain qualities that are hereditary, which, though they may in time be a little changed, it is hardly possible to abolish.

The



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The other circumstance is Exercise. Nothing is more evident than that the Animal Machine is designed to be an active one, and accordingly, if these functions are not employed, it is apt to languish, but, when moderately employed in action, all the Functions of the System become stronger and nothing is more certain than that exercise within the bounds I speak of strengthens the solid or increases its density and force of cohesion. The manner in which it operates is not always so clear, but in the first place it strengthens in a remarkable manner the assimilatory powers. It undoubtedly likewise strengthens all the circumstances under the head of application. By increasing the action of the vessels it gives opportunity for Extension & consequently the proper application of Nutritious fluid.

4<sup>th</sup> Exercise has moreover a great share in abstracting the superfluous humidity ( ) & therefore both from Theory & Observation of the Fuel we may perceive that the degree of Exercise will be a chief cause of the effects of Aliment; and this single circumstance will compensate a great defect in the other



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other circumstances we have been mentioning. We every day see the more laborious persons living upon a small quantity of vegetable food acquire a stronger Fibre than the indolent lazy citizen fed upon the strongest Animal Food that can be acquired.

In the whole of this consideration I have considered our solid parts as merely distinguished into the more fluid & more firm portions; and I always supposed them to be of a given nature and only considered their different proportions of humidity. I have as little as possible considered the firm portions as a mixture of different parts which may be varied by different Matters intermixed with them. These I call præternatural Matters; but we can say very little with regard to them. We know several cases in which such a præternatural Mixture can be supposed to take place, but we only know them as so many Instances of fact, the particular Matters are very seldom at all known to us.

I will further say that in the several instances where we know these to take place we cannot with regard to most



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most of them ascertain when the operation is by vitiating the Nutritious Juice; or if in many cases they are not to be considered as external Applications. I must likewise now take notice that the supposition I made with regard to the Nutriment & Alimentary Matter is not strictly true & correct: Our Nutriment is not exactly of one kind & only to be considered with regard to the quantity of fluid; our Aliment manifestly consists of some variety & therefore we must suspect that this difference likewise affects the state of the Nutriments. We can only understand the application of this. Thus if the state of Mixture in vegetables & animals is any thing different we can suppose that some difference in the mixture of the solid may arise from the different proportions of Animal & vegetable Matter in our Aliment; and though by Assimilation they come to be nearly of the same nature yet this will depend upon the Assimilation being more or less complete: Thus in Vegetables an Acid abounds, but in Animals this has disappeared and there are Substances rather to be considered as Alkaline, & hence as the Assimilation is more or less perfect



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fect, the acid may not be destroyed entirely. I think it proper to give you this view of the variety that may occur in Animal Solids that you may see there is still room for enquiry & consideration upon this subject, but I will say that it will be a subtle enquiry, and it is but rare that any such differences arise. It is however possible they may arise though we have not sufficiently certain chemical principles to proceed upon nor any certain facts and experiments to conduct us in discovering them. This finishes <sup>the</sup> consideration of those powers affecting the composition of our Solids & acting internally.

The external Applications come next, & it may be supposed here we can talk very clearly, at least more so than with regard to the last subject; but this happens not to be the case, for many difficulties attend any consideration that occurs here.

It is certain that Water coming any how in contact with our Simple Solid will insinuate itself into its substance, & consequently changes its several properties of Cohesion, Flexibility &c. But we must take very great care of supposing that it is always  
in



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in this manner of insinuating itself into the substance of our Solids that produces this effect. we must consider to what part of the body it has access or to which we can apply it. Thus we apply Fomentations to contracted Ligaments with a view to relax them, and it is possible they may do so, but not I think by immediately reaching them. I can readily perceive that Water can be applied to the Cuticle & can in a considerable degree relax it, and in consequence also relax the subjacent parts as the Cuticle being elastic closely embraces them, & so far we can understand its operation, though this is not the common Idea but that the Water insinuates itself into the interior parts. I can find little evidence from experiment or Theory. Water is certainly taken in copiously at the surface of our body, but this is by the absorbent Vessels, from whence it is conveyed to the Thoracic Duct & thence into the Blood through the Subclavian Vein: but we have no reason to believe it stagnates long in the extremities of the Absorbents, & as little is it presumable that it is communicated from these to the immediately surrounding parts of the



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the Member we would relax. It may be supposed that, as the Cuticle is considered as an extremely porous membrane, these pores may admit Water to the subjacent parts. It is true the Cuticle is very porous as giving constant Issue to the perspirable Matter, and many of them are so patent as to give Issue to a grosser liquor in the form of Sweat. Most of these however issue in vapour, or if otherwise it is by particular pores that correspond to the extremities of vessels & Water could not enter these without a retrograde Motion in these Vessels which there is no reason for admitting, or if they did they would still be in the same state with the absorbents: but we find in fact by Experiment that the Cuticle is not so porous a Membrane for we often find a fluid & a very thin one too collected under it & forming a Blister without finding any Issue. If therefore it does not let Water pass readily from within outwards how can we suppose it will allow any considerable portion to pass from without inward: moreover, if it were so pervious a Membrane, we should upon occasion see the effects of this;



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this; but I never heard of, nor ever saw, a portion of Water collected under the Cuticle after a Tomentation. If it be alledged that these do produce some degree of Oedematous state I think it is more fairly ascribed to relaxation occasioned in another Way than the actual insinuation of the Water.

I cannot therefore admit that Water proves an Emollient to any depth in our body by insinuating itself into the Solid, and I conceive its relaxing effects with regard to the deepest seated parts may be otherwise explained.

1<sup>st</sup> They may be owing to the relaxations of the Cuticle itself.

2<sup>d</sup> To the relaxations of the extremities of innumerable Nerves lying immediately under the Cuticle.

3<sup>d</sup> To the relaxation induced by the heat applied,  $\frac{ch}{w}$  in some measure penetrates the subjacent parts; and to the heats filling the vessels of the part to a greater degree with fluids, which induces the circumstance of laxity.

Whatever else there is must be imputed to the frictions usually



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usually employed at the same time, which the relaxation of the Cuticle & the filling of the Vessels very much favour.

This method I have seen have considerable effects in curing distortions of the Joints depending upon contractions of the Ligaments: In proof of all this we find that Oils are powerful Emollients, especially when joined with Friction, and it is scarce allowable that they enter the Solids at all, but that their effects are intirely confined to an Operation on the Surface, and therefore we can suppose Water to operate in the same Manner.

With regard to Emollients I will further say, that, if there are difficulties with regard to their external application, they are still greater when applied to the internal parts.

The internal surface of every cavity of the body is constantly defended by a Mucus, which, while it remains, prevents the penetration of any other Matter. If you suppose in any case that this is uncovered, which will be but a very rare occurrence, there will still remain the difficulties mentioned above: Hence I can by no means admit the power of Water or other Emollient in relaxing



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ing the sanguiferous System or even the Alimentary Canal. Further, to hint at every thing ~~thing~~ that may occur on this Subject, there may be an overproportion of Water present in our blood vessels <sup>ch</sup> which may induce considerable laxity in every part of the System; but not by affecting the composition of the Simple Solid but by being poured into the cellular Texture and giving it a flaccidity & laxity; of which more when we come to the organized Solid. How necessary therefore is it on the whole to distinguish the effects of the Simple, & Organized, Solid.

With regard to Astringents the Theory is still much more difficult. Their entering into the substance of our Solid is by no means so obvious as in the case of Water; or if they can enter, their effects in condensing the Solid and increasing its cohesion cannot be considerable. But admitting their power in one or other of these Ways it cannot be great in the Animal body, for what has been said of Indolients will still be much more applicable to them. It shall be offered as a fact that Astringents introduced into the Alimentary



# Simple Solids

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mentary canal leave their effects behind them, all this I would say is extremely doubtful: for their only evident effect is upon the Nervous System and in consequence upon contractile Fibres. If I put a small portion of Alum on the surface of my Tongue I find a constriction not only upon the part but extended over the whole internal Mouth & Fauces whither the Alum cannot be supposed to have extended. This effect however will not happen if the Sensibility of the part is destroyed, nor will it in a dead Person. The operation therefore is obviously upon the Nervous System, & very inconsiderable, if any, upon the Simple Solid; which we shall find confirmed by every circumstance in the actual practice; but of this more hereafter.

It was also proper to comprehend the other powers affecting the composition & properties of the Simple Solid: Thus the caustic Alkali will destroy it entirely or in a less degree will evidently diminish the force of Cohesion &c. These I have classed altogether under the head of Various Matters; but to detail the particular Substances must be left to Chemistry & further Experiment.

It



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It would certainly appear at first sight that the whole of this Subject of external Applications ~~external Applications~~ might be brought to the test of Experiment but there have been as yet but few made except some by Dr. Haller & those of Dr. Bryson Robinson of Dublin, on which I shall make a few remarks and recommend him to your perusal for further satisfaction.

He has found means by ingenious contrivance to measure the expansion of hairs wetted with different liquors. He takes the extension of a hair when perfectly dry with a given weight, and then wets it with a variety of liquors and finds the difference of extension with the same weight. Every application he tried gave to the <sup>the</sup> Air a greater extension than when dry and there was no one he could certainly call an Astringent or strengthner, hence we would say that these different liquors have more or less of a relaxing power, but he calls them strengthening Powers, with what propriety you will be able to judge. With regard to particulars it is especially to be observed that Water alone relaxes much more than when impregnated with most of the Substances



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stances he tried, & warm water has more effect in relaxing the Fibre than any impregnation whatever or any other Substance except concentrated Acids & Alkalies, which affect the mixture of the Fibre, and hence a tendency to reduce it to a fluid form, but nothing that remained in the composition of the solid equalled it. The only conclusion I can make is that warm Water is the greatest Emollient we have, and that all Mixtures upon this quality by making the Water unfit to enter into the solid Matter. You will also see a remarkable difference in the several substances from the common opinion; but this I must leave to your own leisure, and only remark that in several of his Experiments some inaccuracy is to be suspected, in many of them a proper discernment in Chemistry is plainly wanting, and very often a mistaken Chemistry is applied.

We have now finished the consideration of the causes acting upon our Simple Solids by affecting their Composition; whether this proceeds upon the supposition of the Ingredients in that composition ~~of the ingredients in that composition~~ being uniformly the same and only differing in proportion, or that the several ingredients



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dients are various qualities by various matter introduced either mixed with the Nutritious juices or applied externally.

We now go on to consider the causes affecting Concretion, that is, supposing the whole circumstances of the matter of their composition giving certain circumstances that may vary the condition of these parts with regard to one another.

I do not venture here to proceed to my subdivision, well aware that it is extremely difficult to determine. What may the different circumstances of concretion in bodies it may appear at first sight the only circumstances in it are greater or less contiguity of the particles, but there are evidently other circumstances to be attended to, as for instance the motion the parts admit with regard to one another; but though I have offered some general notions with regard to a Theory of Cohesion & Concretion, yet they are not such as I would yet choose to apply to practice.

The 1<sup>st</sup> of the causes affecting concretion is the condition of heat & cold. Here if we were to enter into Theory there



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there might be room for some curious speculations. From the view I have given you it would appear that heat operates upon bodies chiefly by exciting the Elasticity of the internal Air. How it does so we would perhaps be at a loss to explain: for our present occasion we must rest satisfied with the fact that heat expands and rarefies all the bodies in nature except some of those it decomposes, wherein it abstracts some part of their matter and makes them appear to be condensed. Thus moist Earth is condensed by heat, the water being separated in vapour.

2<sup>d</sup>. It is true with regard to all the bodies that come under any observation that in rarefying them it increases their flexibility, and in consequence of the same operation it weakens at the same time their force of Cohesion & their Elasticity, at least if we can distinguish the difference of the effects of an extended Elastic contracting itself and of the extent of their Oscillation, as heat by increasing flexibility give opportunity to a more extensive Oscillation.

It



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It is equally well known that Cold lessens flexibility but increases the force of cohesion and of the elastic power. Heat therefore as an emollient, & Cold as an astringent, are the most powerful remedies we can apply to, and we seldom endeavor to obtain the relaxing power of Water ( ) without giving Heat to it.

Heat is a powerful emollient upon another account, because it penetrates deeper into the substance of our Solids; but Cold as an Astringent is not so powerful with regard to living Animals, because it does not penetrate so far as there is a generating principle in Animals counteracting its effects, and perhaps generally exerted according to the cold applied. Their effects therefore appear very considerable upon the Animal Body in general, but it is only an inconsiderable part of them is exerted upon the Simple Solid. Their operation on the Nervous System is vastly more considerable; but it is not proper to enter upon this distinction at present.

Further, with regard to these powers, let me observe



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serve, that though in the Table I thought necessary to refer <sup>g</sup> several remote causes to the head of the proximate Cause to <sup>ch</sup> w they more immediately belong, yet the remote causes very often operate upon several of the proximate causes at the same time; thus heat & cold have considerable effects upon the composition of the Simple Solid. This I said very much depended upon the powers of application. I could not enter into the effects of heat & cold on this till now, but in the application of Nutriment heat has a large share.

1<sup>st</sup> perhaps by giving a more perfect fluidity to the Nutritious Juice.

2<sup>d</sup>. It has considerable effect in increasing the activity of the powers by which the nutritious Juice is distributed to different parts of the body, whether this is by the ordinary circulation of the Blood, or, as I rather suppose, by means of the Nerves.

3 Heat contributes to the application of the Nutritious Juice by the expanded state in which it constantly keeps the Solids; which may either be considered under the head of Tension,



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Tension, or as preserving the substance of the Solid in a more rare & porous Texture, or, as favouring the power of Solution, it may contribute to the insinuation of the Nutritious Juice into the Solids.

4<sup>th</sup> and lastly, as we have reason to believe heat is one of the principal means by which the superfluous humidity is extracted, ( ) it thus contributes to the formation of the Solid; you will readily observe that in a great measure Cold must have effects contrary to all these.

I think you can now perceive the reason of a curious but pretty constant effect; viz that in the warmest climates Animals grow fastest & soonest arrive at their Acme, and all the functions connected therewith; while in the coldest climates all Animals are stunted in their growth and are of a smaller size. This in general we can refer to the circumstances of heat & cold operating on Nutrition: but there are certainly many exceptions in this case, & I would not conclude against the existence of Patagonians merely because they are said to be found in



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a very cold latitude. There are many other circumstances that concur in determining the size of Animals; such as Diet, Exercise, state of evacuations, of the Mind, & Passions &c.; which all receive a peculiar modification from the heat & cold of the climate. It is not therefore the immediate effects of heat and cold, but so far as they operate upon diet, exercise, &c. All these also operate upon the Simple Solid & Nervous Fibre, and therefore this subject of the state of Animals in different climates is as complicated as any in Physick.

The next cause affecting the concretion of the Simple Solid is what I have marked under the name of Pressure. This too, as well as heat and cold, has an effect upon the composition of our Simple Solid; for when I spoke of Exercise I did not mention all the effects of it, thus it is well known that pressure however produced occasions a very different state of density in the Cellular Membrane, in consequence of which there is a different state of strength and rigidity; but of this more properly hereafter. Physiologists to shew that Pressure has an effect upon



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upon the concretions of our Simple Solid adduce an analogy from Metals, which by hammering are made denser; but how far this is applicable to Animal Solid is both uncertain and very difficult to be ascertained by any experiment. It is to be observed that this effect is more remarkable upon soft bodies; thus upon Lead more than Iron unless this is softened by heat. Now allowing Animal Solid to be among these, still the compressing powers are very weak, and are not sufficient to have any of the effects of pressure, and therefore very little in the changes of the more Simple Solid is to be attributed to it tho' it universally operates upon the Organized Solid. It does not however, I think, deserve the notices that Gaubius and others of the Boerhaavian School have bestowed upon it.

The third cause is Tension. To understand which I must observe that it is in common to all elastic bodies that the more they are stretched the more force is required to stretch them further, and this takes place till the point of breaking. This is in common to all Elastics & Animal Fibres so far as we can subject



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subject them to experiment: But this is only with regard to the flexibility of the Fibres, it makes no odds in the force of Cohesion it still requiring the same power, to separate them as before; but the force of Cohesion may be considered as growing constantly weaker according as the extension is carried further. The state of flexibility as thus depending on the degree of Tension is of very considerable and extensive application in the Phenomena of our System; for we must presume that our whole solid is in a state of Tension and it is only in this state that they can shew the force of Elasticity. It is also necessary to attend to the several powers by which this Tension is constantly maintained. And in the first place a great portion of our Solid Matter is fixed to the Bones at their different extremities, and therefore it must be by removing to a greater distance these fixed points that the interjacent Solid is stretched out; and this is a principal foundation of the Tension different parts are in; but as the bones, being joined by articulations, are moveable to different sides, the contractility of the opposite parts must constantly balance to keep



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keep the state of Tension established by the growth of the Bones; <sup>the</sup> <sub>to</sub> are called the Antagonist Powers. Besides this there are sets of the Solids that are not employed in sustaining the weight of some Member or other.

The soft parts often form cavities filled with fluids in Motion, which are constantly distending the sides of these cavities not only laterally but longitudinally; thus in the whole arterial system you can easily see from the force of the blood and the form of the Arteries that this is the case and it can be proved by experiment; for when an Artery is emptied of its blood it contracts in its diameter, and when cut through transversely it contracts towards both extremities. This is a principal circumstance with regard to the tension of Animal Bodies, and extends to the cellular Tissue connected with the vessels. These are pretty constant and steady, but in other parts of our Solid the tension is not so uniform, but is in different states according to the fluid contained in them; such is the case of the Lungs, and the Alimentary Canal is more subject to variations in this way than



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than any other part of the System.

There are also other means of Tension, thus the Cellular Texture is not only extended by its connection with the other parts, but probably also from the vapour exhaled into it being still in some measure in an elastic state. Some Physiologists have gone further & alledged that the finer parts of the Cellular Texture have an elastic Air contained in them; but the matter is <sup>not</sup> yet exactly ascertained though from several presumptions it is very probable; For this consult Mr. Senac in his treatise on the Heart. I shall next observe that in case of any additional Power the Oscillation will be more or less considerable according to the previous tension of which more hereafter. You will find that lesser powers than those otherwise required to break the fibre will have this effect according as the parts are more or less in tension; which Boerhaave and his followers have taken notice of as a state of weakness, under the title of *Distractio fibrae rupturae proxima*.

There is also another notion expressed by Dr. Gaubius under



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under the title of "Violenta partium ultra tonum distractio;" who supposes that there is a certain state of Extension, which, though not amounting to a rupture or breaking, yet destroys the tone or contractility. This however, so far as I can observe, does not take place in proper Elastics if the extension is made at once. I am at a loss to find a proper and correct notion upon this subject. This is one; viz If a Chord consists of a great many different fibres, these fibres may be of different degrees of strength and that at different parts of the Chord, and therefore a great extension will break many of these fibres at different parts of the Chord; so that it will still keep the appearance of Cohesion but certainly lose its Contractility. This is another Idea; viz that if a chord, or rod of wire approaching to softness, some of the particles may be removed to a greater distance than is compatible with contractility, but may still preserve a lateral cohesion; but how far any of these suppositions will apply to the Simple Solids of Animals I am at a loss to determine. It is not to be ascertained by any experiment though some of them happen in the organized Solid.

I must



\* When the Bladder of Urine is kept long in a distended state, tho' the cause be removed, the Fibres do not contract but remain paralytic.



# Simple Solids

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I must say this that with regard to the Simple Solid the whole is a mistaken Analogy, and the Idea is taken from Muscular fibres where it does appear that a certain distension brings on a Paralytic state; <sup>\*</sup> but this must not be transferred to the Simple Solid, and as an affection of Muscular fibres will be considered more properly hereafter.

I must observe before I leave this subject a manner of speaking in D<sup>r</sup> Haller that I am persuaded is not quite correct. It is observable in the 391 & 393 Parag: of the *Primæ Lineæ*, where he says that the parts of solid bodies, and particularly the parts of elastic bodies, are never at rest, but constantly moving into a nearer and nearer contact of the particles to one another. This may lead us into mistakes as it is by no means certainly established: Thus when a metallic wire is stretched by forces applied, when these are removed it returns into the same dimensions as before; which I suppose to be the natural dimensions to which bodies of that kind would reduce themselves, but D<sup>r</sup> Haller, alleges that if allowed to be long at rest it will still contract into smaller  
and



# Simple Solids

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and smaller dimensions. This I cannot conceive to be the case unless by different temperatures of heat & cold, and therefore I think there is no sufficient proof of the Nuis in contactum. My reason for insisting on this is that if in any case we perceive such contraction operating as we often do on our Simple Solids it is only to me a proof that such body was in a state of violent tension or stretched beyond its natural bounds.

The last cause affecting the state of Concretion in our Simple Solid is what I place under the head of Motion & Rest; which I own, for the sake of the tabular form, is more concise than clear. It may at first sight be supposed to signify Exercise or the want of Exercise; but I only want to express one effect viz the motions of the particles of Elastic bodies upon one another. This motion we find capable of being increased or diminished, and besides the other causes of flexibility, especially those of its being increased by frequent motion and diminished by rest. If a body is frequently bent and allowed to contract again it acquires more flexibility; but, if allowed

to



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to be long at rest, either extended or contracted, its contractility will become less considerable. There are many cases in the Animal body in which we suppose this to take place. There are many of Tendons, Ligaments &c, which if allowed to continue long either extended or contracted, become in the one case quite flaccid, in the other quite rigid. Though this is a little complicated with the doctrine of Muscular Fibres, yet from Analogy we can conceive it taking place in the Simple Solid. — This finishes the consideration of the several remote causes affecting the concretion of the most Simple Solid.

We now proceed to consider our second great division, the Organized Solid, the general Idea of which I gave you before. It is when different portions of an Aggregate are so placed and situated with respect to one another, that from their Situation they become Organs fitted for certain purposes which a promiscuous situation of the portions would not answer.

When entering on the last head of Concretion I said that I found a difficulty in arranging my proximate causes.

The



## Organized Solid

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The same happened here. I was not able to refer them to any general head and therefore contented myself with enumerating all the remote causes; but I say now they may be reduced to a few heads, and particularly the increased density of the Cellular Texture, and its increased laxity.

The 1<sup>st</sup> I have mentioned is Rest; and here it must be understood to mean Rest in a contracted State of Cellular Texture or other parts of our Solid Matter. This Fact is very well known viz that if any of the Cavities remain for any length of time in a contracted state they acquire a rigidity so as not to be stretched out again by the usual powers. This happens frequently in the bladder of Mine when irritated to contraction by a Stone. By the particles of Simple Solids remaining at rest they lose their Elasticity.

Rest however produces this effect by various means;

1<sup>st</sup> Is the state of Simple Solid by its particles remaining thus at rest.

2<sup>d</sup> This belongs to Organized parts only viz that in this contracted state we must necessarily suppose the plates of the Cellular



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lular Texture brought nearer to one another or even close together, and, as we shall see immediately, when the parts of Animal Bodies are brought into close contact, and kept there for some time, they cohere or are united together.

3<sup>d</sup>. cause is the contracted state of Cellular Texture; which must necessarily constrict the extremities of the several vessels that run in it and particularly the adjacent vessels, whereby the exhalation of a Vapour is lessened or prevented which keeps the parts asunder.

4<sup>th</sup>. This contracted state of the Cellular Texture must likewise affect the Absorbent Vessels, whereby the fluids must be disposed to Stagnation and consequently to a concretion. From all this together you will readily perceive why Membranes, lying long in a contracted state, must not only lose their contractility, but also become denser.

The 2<sup>d</sup> head of remote causes is Pressure.

This the cause of very considerable effects in the Animal Economy; one of which (its giving a greater density to our Simple Solids)



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lid) I mentioned as doubtful; but what I now speak of is an increase of density in cellular Texture when the body is arrived at its Acme, or, perhaps a little further, when we presume it has acquired in all its several parts the whole of the solid Matter it can admit, which may be a question; but it is I say a presumption, except where substance is actually lost. The whole of the firmness & rigidity the body after this acquires seems to be fairly imputed to the condensation of cellular Texture, though the expulsion of the fluids from the small vessels and the obliteration of these vessels may concur. There is no part of the Animal body but what is exposed more or less to Pressure in the several motions we perform.

Mr. Du' Hamel supposes that many parts of the loosest cellular Texture may by pressure acquire more & more firmness and at last put on a cartilaginous form; and he really produces several instances.

I can add another curious proof that if compare the density & strength of the correspondent Veins & Arteries in  
Ed



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In young Animals, the Veins in young Animals have a greater force of Cohesion in proportion to that of the Arteries than in Animals past their Acme. For this consult Dr. Witheringham Junior's experiments. The meaning of this is that the Arteries, especially those near the Heart, are constantly exposed to a great degree of Pressure, in so much that they might be supposed to proceed to a harmful degree of rigidity, but to prevent this Nature has provided them with a laxer Cellular Texture, while the Veins that are not exposed so much to this pressure have their rigidity given them from the beginning.

The Human System hereby evidently appears designed to have an End, for the continued pressure on the Arteries constantly increases their cohesion, till at last an absolute rigidity, and even ossification, takes place. The effects of pressure therefore are continually exerted in increasing the density of Cellular Texture, till at last the Mors Senilis, which few attain to, but all are liable to, is brought on.

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The 3<sup>d</sup> Set of remote causes are what I have put under the general title of Concretion, which is here meant with regard to Organized Solid, and the Concretion is of parts which should naturally be disunited and separated.

This Concretion may be considered as of 3 kinds;

1<sup>st</sup> Which is the most simple is the uniting the surfaces of plates of the cellular Texture applied to each other which should be naturally separated and disjoined; and this without the considerable interposition of any other Matter

2<sup>d</sup> Is in parts that are united by a continuation of Cellular Texture, as when a part of this is destroyed and the parts are united by a Licatrix, by which they become of less extent than before.

3<sup>d</sup> Where Membranes naturally disjoined are united together by means of an interposed quantity of Matter, which concretes of itself and serves as a Cement to the other parts.

For the first mode of Concretion (the uniting portions of two Membranes) nothing more is necessary than bringing and keeping



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keeping the surfaces in contiguity, and then probably by means of a fluid exuding from either surface they are cemented and glued together, as most part of our fluids are of a viscid gelatinous nature, and therefore in this case may serve as a proper cement. We have only therefore to find out the causes bringing these parts into contiguity; which are Collapse & Pressure.

The various modes of pressure that may take place here you will readily suggest from what has been already delivered.

Collapse is where there is a cavity kept commonly distended by a fluid, if that fluid is withdrawn the sides of the cavity become flaccid and fall together, and it is not of a particular form. Thus there are many cavities in the body, particularly the whole Arterial System, that are endued with such a considerable Elasticity that contracting equally on all hands they still preserve their circular section. The Veins being more lax, it is supposed Collapse may happen in them; as in the Umbilical Arteries and their corresponding



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corresponding Vein degenerating after Birth, when fluids are no longer propelled through their cavities, into Ligaments. It is doubtful whether it happens in the Alimentary Canal or not. Such concretion happening in the Alimentary Canal, or Arteries, is rather to be imputed to Pressure.

Many Membranes in the Human Body are in contact but do not however conrete, as in the Pleura & surface of the Lungs, the Abdominal Viscera with respect to the Peritonaeum and one another &c. This is owing partly because that these Membranes are not allowed to remain almost a moment in their contiguous state, and probably because they <sup>have</sup> constantly interposed a fluid not disposed to concretion. — Thus the cavities of the Thorax and Abdomen are constantly filled with a Vapour or Halitus; which, while in the state of vapour, or in a very fluid form, and constantly renewed, certainly prevents any concretion of the Surfaces.

The case in which Concretion most commonly happens is, 1<sup>st</sup> that of Inflammation, by which the Membranes



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branes are not only applied more closely together, but it is now known that the surfaces of the inflamed parts pour out a fluid which forms a tenacious crust and unites the membranes together; and this perhaps is the most common cause of the cohesion & accretion of the several parts we just now took notice of.

The 2<sup>d</sup> Mode of Concretion, Cicatrix, is sufficiently obvious. It is always the consequence of Abscesses where much of the cellular texture is destroyed, whence the skin is glued down to the Muscles, these to one another and to the Periosteum &c; hence we understand why this has been proposed as a cure of Hernia & sometimes with success, and tho' now for its uncertainty laid aside, yet a practice of the same kind is still in use in what is called the radical cure of the Hydroroele.

The 3<sup>d</sup> mode of Concretion is by a more manifest interposition of a quantity of glutinous Matter.

You will perceive that Inflammation is strictly a case of this kind, but they are easily distinguishable; for in this case



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case the Gluten does not arise from the surface of Membranes but from a considerable portion of fluids interposed which should have passed through them. I have said that a considerable part of our fluids is fitted to have this effect, but it is only the coagulable Lymph that usually stagnates & forms these concretions: Of this we have frequent instances in the Thrombus or Plug, which stops the orifice of Arteries when cut through; and it is somehow in this way that the umbilical vessels of <sup>the</sup> Fœtus are changed into solid chords. How many morbid cases may arise from this case is not properly ascertained.

I am doubtful whether I ought not to refer to this last head the several cases of Ossification & concretion that occur in the System. From Du' Hamel's experiments on the formation of the Bones I am persuaded Bones are formed by layers of a Membrane that is at first cellular Texture; but the after firmness is not to be imputed to pressure alone but to an earthy matter poured into the cellular Texture and hardening there, giving the firmness we speak of - Mr Du Hamel illustrates



trates this by a very pretty experiment of washing the earth out of the cells. It is in the same manner that Acids operate on the Bones in softning them by extracting this earthy matter of which they are solvents. The same is the case with the Petrifications, only differing in the qualities of the Earthy matter that is poured into the cellular Substance.

I go on to the 4<sup>th</sup> head of remote causes, viz  
Loss of Substance, of which I think we may take notice of 3 Cases;

1<sup>st</sup> Erosion by certain acids (we would call them solvent substances) which are produced in the body itself; as in Ulcers of various kinds & particularly Cancers, where the Matter having eroded half the coats of the vessels, in consequence of that they give way & troublesome hæmorrhages ensue.

2<sup>d</sup> When the hardning matter of the Bone is again washed out, which we know from several instances does in fact happen, and is exactly analogous to Mr. Duhamels experiments



ments or when we apply Acids. I should before have noticed that if we apply to the bones a strong Acid the whole substance is consumed as in the case of Erosion; but if only the weaker Acids, as Vinegar, the Earth alone is dissolved: but how such a Menstruum can be produced in the body we have not yet learned.

3<sup>d</sup> case is Overstretching, which indeed I have made a separate article, but it is best to speak of it here.

It is of 2 kinds,

1<sup>st</sup> When it produces a breaking of some part of the Cellular Texture, when the part will be unequal to sustain the weight, impulse &c, of the part it is devoted to.

2<sup>d</sup> When two parts are connected together by a Cellular Texture of a certain length, & of a given thickness with that length, if these parts are drawn asunder, the Cellular Texture will be diminished in thickness, and consequently there will be less of it to sustain a particular part. From this we explain the origin & increase of various Herniae.



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We now come to the 6<sup>th</sup> Head, which is the ef-  
fusion of liquids into cellular Texture. This may be divided  
into 2 heads,

1<sup>st</sup> Matter remaining fluid.

2<sup>d</sup> Matter hardening.

The last of ~~the~~ these I have already spoken of.

The first I think must be understood always of the ef-  
fusion of preternatural Matter, or at least in preternatural quan-  
tity. To explain this I observe that a great part of our Cellular  
Texture is generally filled with oil; but to preserve the Elastici-  
ty it is probable that such Adipose portions are always ac-  
companied with a part of Cellular Texture filled either with  
elastic Air or with a portion of vapor; in either of which ways  
the Elasticity will be preserved, but if filled wholly with fluid  
it would not. The case of Cellular Texture filled with such Va-  
por is frequent in the System. This Vapour in health we  
must imagine to be quickly reabsorbed, but if it stagnates  
for any time it will be condensed, and if in large quantity  
it



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it will destroy the Elasticity of the parts, forming the inundation agross of Boerhaave & Lantius, which appears so evidently in the Oedema, Anasarca &c.

7. The last of the remote causes is the case of new Accretion.

In what manner a new growth of Cellular Texture will strengthen the Solids in that part is sufficiently evident, but how it is produced is not so well known. One way we do know, viz that if Membranes are very slowly & gradually stretched out, so as not to come under the head of Overstretching, the membrane will become thicker and stronger than before, which is a provision made in our Economy for obviating the effects of Diseases.

I have now, I think, mentioned all the causes, at least the most of them, Proximate & Remote, of the different states of Animal Solid. There is but one upon reflection I can take notice of as omitted: When speaking on the head of Solid Substance I should have observed that many of our Organs consist of several parts, or layers, so that the strength of



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of the whole depends on the integrity of all these layers; therefore if any of them are cut through the whole is weakened & rendered unfit for its office; thus if a Ligament is half cut through it becomes unequal to sustain the part, if the Skin & Muscles of the Abdomen are cut through the Peritoneum is unable to contain the Viscera, & a Hernia is formed.

I will likewise observe that the firmness of our Solids very much depends on external and artificial assistances, at least the constant use of these for any length of time renders them afterwards absolutely necessary; hence Systematics have very properly included the removing accustomed Ligatures as a cause of Disease. Under this head the pressure of the Atmosphere might be considered, but it will come in more properly hereafter; though even there I shall not be able to explain it in a satisfactory manner and it does not appear to be so considerable as is imagined: of this we have a remarkable instance at present. We have had for these three days (Nov<sup>r</sup> 24 1768) a greater diminution of the gravity of the gravity of the Atmosphere than for many years



years. and yet I do not hear that this has produced any great change in the constitutions of the people; but I would not reject it entirely as there have come under my observation three people who have died of Apoplexia during this period.

This then finishes the whole consideration of these causes, & I shall now only make two or three remarks:

1<sup>st</sup> I take it to be a general rule with regard to the Animal System that the fundamental parts are most steady and least liable to alteration, of which kind I consider the Simple Solid. The state or condition of the Simple Solid is more certainly determined by the state of the original Stamina than any of the other causes we spoke of. Most of the other causes that operate considerably are such act during the formation of the Solid, viz the several circumstances & powers of Nutrition, and I allege that the Solid once formed and arrived at the adult state undergoes very little alteration. This circumstance of the Simple Solid along with the other causes must constitute a predisposition. Most of the causes I have now detailed require a great length of time in



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in order to make any considerable change in the Simple Solid, and therefore in those cases where there are very sudden changes we must not seek for them in the Simple Solid but rather in the Nervous & Hydraulic Systems.

In the last place, altho' the state & condition of the Simple Solid produced slowly has indeed a concurrence in the causes of many Diseases, and particularly in forming what we call the Organic Diseases, yet in the System of Boerhaave and his followers much more is imputed to the Simple Solid than I think ought fairly to be done. I must recommend to you to consider what D.<sup>n</sup> Gaubius has said upon this subject in his 162 & 166 Parag: I also recommend to your consideration how Boerhaave and his Pupils have treated the same subject. I will venture to assert two things, viz that the writers of the Boerhaavian School are neither full nor correct on this doctrine, and while they are deficient with regard to the consideration of causes they have imputed, as I just said, many more effects to the Simple Solid than they



they might have done.

The proper trial of the whole of our doctrine is the application of it to Pathology where we invert the order of Physiology, first considering their effects, and then tracing up these to their causes. I have said that we shall sometimes join the Physiology & Pathology together, and there is no where it can be done with more propriety than here, & this has been the practice of all writers on this subject.

Before I enter upon it let me observe again that I am going to speak of the Diseases of the Simple Solid. But many of these never do by themselves occur as separate Diseases being commonly only a part of the proximate cause of many different Diseases, and therefore several Systematic Writers have refused to treat of them as Diseases but have proposed a separate Title as Vitia, Affectus, Diathesis &c; of this see more in the 121 to 124 & 267 Parag. of Gaubius's Pathology.

On our plan of considering the Vitia of the Simple



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Simple Solids. They are in general to be referred to an Excess or Defect in the several properties of Elasticity, Flexibility, & Cohesion. I hinted before that we must always consider this defect or excess as relative See the 155 & 166 Parag: of Gaubius: thus the force of cohesion, flexibility and rigidity of the Arteries is only a condition that is relative to the power of the Heart in that System, (that is) altho' the rigidity of the Blood Vessels in one Man be twice the strength of those in another yet if the Heart be of a proportionable strength there will be no defect nor excess in either System; hence it is that one person may be called weak & another strong & yet the powers of each System exactly correspond to their several component parts.

The excess & defect in the force of Cohesion &c of the Simple Solids are first to be considered as they occur separately in the naturally soft & naturally hard parts, which Dr. Gaubius has conjoined but I will take them separately.

The defect in the force of Cohesion of the naturally soft parts must be separated as occurring in the more Simple



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Simple Solid, and in the organized parts.

In the most Simple Solid it is to be considered of 3 kinds & perhaps more.

1<sup>st</sup>. As it is unequal to resist the powers tending to a total separation or rupture of the parts.

2<sup>d</sup>. Where the Cohesion does not sufficiently resist the extension of the parts within the degree that flexibility requires.

3<sup>d</sup>. When with the last circumstance, even when the stretching powers are removed, it does not operate in bringing back the Solid to its former state.

The 1<sup>st</sup> I call the case of absolute Debility, the second the case of Laxity, & the 3<sup>d</sup> that of Flaccidity.

Here I differ from Gaubius who has considered the whole of these cases under the title of debile whereas the 1<sup>st</sup> is only the proper debile. He makes the fragile too a species of the Debile, which I shall rather consider as another division. Now I cannot think his scheme correct, for tho' tis true that  
what



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What we strictly call Debility is often joined both with laxity and flaccidity, yet they are truly occurring separately, though were they not we ought to consider them separately. We can easily also illustrate this from the Analogy of other bodies; thus the cohesion of Gold is much greater with regard to its flexibility than that of Lead.

The 1<sup>st</sup> Division therefore, Debility, may depend either upon the state of composition, or upon the state of concretion.

As depending upon the state of Composition it will be in the first place in proportion to the fluid & firm parts in our Solid.

2<sup>d</sup>. It will depend on the vitiated mixture of the firm parts.

The defect of firm parts giving this weakness of cohesion will again depend upon the Original Stamina; thus we said the different Sexes, and Individuals of the same Sex, have their strength & debility depending on this cause.

In the next place that being given, Debility may be



# Pathology of the Simple Solids. III.

be owing to weak Nourishment either with regard to quantity or quality, & therefore you will trace it up to the state of Aliment, state of Assimilation &c.

3<sup>d</sup>. Debility may proceed from a defect of the power, by which Nourishment is applied to our Simple Solid, which again will depend upon Exercise.

4<sup>th</sup> & last cause of Debility from encroaching the quantity of fluid in proportion to the firm is Imillents externally insinuated, chiefly or perhaps only Water.

Debility in the 2<sup>d</sup>. place as depending on the composition of the Simple Solid may be produced by causes giving a vitiated mixture of the firm part of our Solids, which are of 2 kinds;

1<sup>st</sup>. When applied in the shape of Nourishment

2<sup>d</sup>. Externally insinuated. This we have mentioned

in the Table of remote causes under the head of various Matters.

These are the causes producing the debility of our Fibre by operating



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operating upon its Composition.

Those operating on its Concretion are,  
1<sup>st</sup>. Heat.

2<sup>d</sup>. The want of Pressure. I have said it is doubtful how far pressure may condense most simple Matter and that at any rate to inconsiderable. Under this head likewise we should mark that particular case of Overstretching called in the language of Boerhaave *Distractio fibrae ruptura proxima*

In the next place the loss of external support or *Ablatio sustentaculi*, of which more fully afterwards. - These are all the causes of debility considered in the abstract.

Laxity is the 2<sup>d</sup>. case of defect of Cohesion and is to be considered as produced in like manner by two sets of causes,

1<sup>st</sup>. Those affecting the composition of our Solid.

2<sup>d</sup>. Those affecting the concretion of our Solid.

The causes affecting the composition are very much the same that I spoke of as operating in producing debility by affecting the different properties of fluid & firm parts in  
men



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our composition; but here Nourishment must be considered as weak with regard to solid substance while it abounds in fluid. On the third head the powers must be supposed particularly deficient in abstracting the superfluous humidity.

The 4<sup>th</sup> is Water externally insinuated.

The causes producing Lascity by affecting Contraction are different,

1<sup>st</sup> Heat.

2<sup>d</sup> Want of Tension.

3<sup>d</sup> A peculiar cause of lacity which does not influence the force of cohesion as far as we can perceive, (i.e.) frequent motion of our Solid.

Flaccidity is the 3<sup>d</sup> case and is produced,

1<sup>st</sup> By an overproportion of fluid or watery parts.

Whether this ever occurs in the way of nourishment may be doubted; but there is no doubt but that <sup>by</sup> Water externally applied an absolute flaccidity may be induced upon the Simple Solid, as in Anasarca People.



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2<sup>d</sup>. By Rest in an extended state.

3<sup>d</sup>. According to the language of Gaubius is the *violenta ultra tonum distensio*, which, tho' I do not know how it operates, must not be omitted.

Fragility is another cause of weak cohesion, which might be put under the head of Debility. This cannot proceed from too great dryness, which in the external parts is a matter of common observation & may therefore occur internally.

It may likewise proceed from another cause, viz vitiated Mixture.

These are the several causes of the defect of cohesion as they occur in the most Simple Solid. We are in the next place to consider them as occurring in the Organized Solid.

It is not here necessary to consider them again under the 4 heads of Debility, Laxity &c. Here the three first are more commonly combined.

In the 1<sup>st</sup> place Debility &c in the Organized Solid



# Pathology of the Organized Solid. 115.

lid may be produced by all the several causes that act on the most Simple Solid.

But 2<sup>dly</sup> there are causes which act upon the Organized Solid only, generally I think by inducing a rarity of the Cellular Texture.

This is referred 1<sup>st</sup> to original Stamina, and accordingly we know in fact that in some Bodies it is more rare in others more dense, and this not only in different persons but in different parts of the same System. Thus in two Men sustaining the same shock, one shall be affected immediately with a Hernia, the other not. With this however frequently occurs another cause of rarity in the Cellular Texture viz

The want of Pressure, which I have explained as taking place in the blood vessels; but there is not a part of the body that is not more or less exposed to Pressure. It is still more clear that the Strength & Debility are in proportion to Exercise which gives different degrees of Pressure.



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sure.

3.<sup>d</sup> The Cellular Texture is rendered more rare by Overstretching. However we may understand the effects of overstretching with regard to Simple Solid, its effects on Cellular Texture are evident.

4.<sup>th</sup> Loss of Substance, strictly that which is performed by Erosion. I will put separately what might be referred to loss of Substance, where, by a solution of continuity, the parts are separated, retracted, & do not support in a place where they cohered before.

5.<sup>th</sup> The overproportion of fluid parts in it, filling its Cells.

In general the Laxity of every organized part of our body will be greater or less according to the quantity of fluid either in the vessels containing it, but more especially <sup>on</sup> the fluid is every where diffused in less elastic parts, as in the cavities of the Cellular Texture.

6.<sup>th</sup> & last cause is the loss of external support which



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which I already mentioned, and particularly took notice of the pressure of the Atmosphere, but I omitted a considerable one which is Cold. The Cuticle being an elastic Membrane as was formerly said exerts a considerable pressure on the subjacent parts, which will be increased when the Membrane is affected by Cold, but more especially when cold affects the Cutis which is a more firm Membrane. Other causes may also act upon this as some passions of the Mind, particularly Fear.

These then are the several causes of the defect of Cohesion. I go on to consider the contrary morbid State or the excess of the powers of Cohesion. These in so far as preventing Rupture never constitute a Disease. It only becomes a Disease when acting so as to prevent the extension the System requires, and therefore with all Pathologists we here consider but one morbid state, viz

## Rigidity.

As occurring in our naturally soft parts it is of two kinds;

- 1<sup>st</sup> Where it is still with some degree of flexibility but such



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such as requires more than the usual force, giving the Rigidum tenax of Gaubius.

2<sup>d</sup>. Where the naturally soft parts have acquired such a hardness as to be altogether inflexible by the powers of our System, as the Rigidum durum of Gaubius; under <sup>ch</sup>is he comprehends his Fragile Vitreum if it ever takes place in the naturally soft parts.

The causes of Rigidity in the most Simple Solid depend either upon the composition or concretion of the Solids.

As depending on the Composition they are

1<sup>st</sup> Original Stamina.

2<sup>d</sup> Strength of Nourishment.

3<sup>d</sup>. They depend especially on the powers of application excited in a stronger manner.

4<sup>th</sup>. External Applications, which I speak of under the title of Astringent Applications.

The causes affecting Concretion are

1<sup>st</sup>



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1<sup>st</sup> Cold

2<sup>d</sup> Pressure

3<sup>d</sup> Tension

4<sup>th</sup> Rest in a contracted state.

We now go to say that Rigidity takes place in the organized Solid, & the causes of it are

1<sup>st</sup> All the several causes operating upon the most Simple Solid.

2<sup>d</sup> Those causes that induce a greater density on the Cellular Texture & consequently Rigidity. These may be produced

1<sup>st</sup> By Rest in a contracted State. We have explained how in this state both the exhaling and inhaling Vessels are affected & the fluid that should fill the Cellular texture being stagnant becomes of a glutinous quality especially when the thinner parts are abstracted, & consequently a degree of Concretion happens giving this rigidity.

2<sup>d</sup> Pressure which I have formerly explained.

3<sup>d</sup> By all the various modes of Concretion. Any two



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two Substances we know kept in contiguity for some time constantly acquire a Coherence: The causes of which contiguity may all be reduced to,

1<sup>st</sup> External pressure

2<sup>d</sup> Collapse.

There is also another circumstance of it when the Mobility of two parts depend on a certain quantity of Cellular Tissue, which when the part is taken away in the middle the parts are united by a cicatrix.

More distant surfaces may also be united together if a fluid is accumulated between them of such a nature as not only to congregate itself but also to serve as a glutin to the other parts.

Accretion is the last cause of the density of Cellular Tissue. The Body only acquires new substance for a certain term of years; but there are particular occasions, as whenever loss of Substance has happened, when such is the nature of the Economy that the function of Nutrition is as it



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it were again excited & new substance is produced. Dilatation also done slowly & gradually excites the function of Nutrition. There are also many other circumstances that may determine to an accretion and therefore mark it as a cause of density in the Cellular Texture. - These are the causes of the *Rigidum tenax*.

The *Rigidum durum* is when the part becomes absolutely inflexible to the powers of our System, which I think can only happen in the Organized parts & this from causes already explained viz Ossification & Petrification; which can only take place in the organized parts because they depend on a peculiar matter, capable of hardening, poured into the Walves of the Cellular Texture. The *Rigidum Durum* is considered by Gaubius as of 2 kinds;

1<sup>st</sup>. Such, that tho' resisting the ordinary force of the System, yet, by a more powerful external force, it will bend to a certain degree before it breaks.

2<sup>d</sup>. The other supposition is such a state that the



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the parts will rather break than bend. If this ever occur in the soft parts it will depend on the same circumstances as in the Bones.

In parts naturally hard the affections are always of Organized Solid. The first affection is where the parts lately hard acquire a softness & flexibility rendering them unfit to perform their functions; whereof there are two cases,

1<sup>st</sup> Faulty Nourishment; where the matter filling up the Cells is either not prepared at all or not prepared of such a kind as to give a proper consistence. Such we suppose to be the case in the Disease called the Rickets.

2<sup>d</sup>. When the matter has been prepared & deposited, but is again taken out of the Cells. This is but a rare occurrence, though we have had of late several instances distinctly marked. This I think can only be conceived to be produced by some Menstruum introduced and dissolving the earthy Matter; but how such Menstruum can be produced, introduced, & absorbed again, does not belong to this place to inquire.

The other affection of the Bones is Excess of hardness,  
which



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which is always with fragility: It is of 2 kinds;

1<sup>st</sup>. That with weak cohesion, called by Gaubius Fragile Spongiosum, constantly supposed owing to vitiated mixture introduced by Nourishment or externally insinuated so as to destroy the force of Cohesion.

2<sup>d</sup>. With strong cohesion, & is the Vitreous Fragility before spoken of. In many cases we may suppose that even the Bones admit of some degree of Flexion.

When they do not but rather break than yield a little we consider this affection as taking place. We may form an Idea of this by considering the different manners of Cohesion in Glass, Iron, or Steel. The only probable cause of this affection is the effect of the progress of Life, whether it depends on the constant addition of hardening matter, or, what is more probable, to length of time, changing more & more the Bones of which we have some proof.

To these D.<sup>r</sup> Gaubius has added another case, the power of Cold, which we know with regard to other bodies gives the vitreous hardness & fragility, and which may surely affect the Bones if the cold



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cold has access to them; but this in a living Body I can never think possible as they are covered with a quantity of soft parts endued w<sup>th</sup> a certain degree of heat, and, if these were affected with the cold, Gangrene & Mortification would be produced and the member would be no longer alive; but as the case alluded to, viz. Fragility of our Bones in time of Frost, is never as far as I know attended w<sup>th</sup> coldness of the soft parts, so I do not suppose that if there is a fragility in our bones in time of frost it can be imputed to this cause, but can easily be explained in another Way. If we consider the hardness, the slipperiness, of the Ground, the many occasions on which our motions are hurried, & we endeavouring to recover ourselves with a greater exertion of strength, these will better account for the frequency of Fractures in these circumstances. With this we conclude the consideration of the Simple Solid.



Psychology of the Organized Series

Syllabus to the

Nervous System.



# Of the Nervous System.

I. The functions of the nervous system are  
impaired in many of the diseases of the system  
and it is important to know the nature of the  
disease of the system of the utmost importance

Syllabus to the

Nervous System.

A General View of the  
Nervous System.

II. The nervous system is made up of the brain  
and spinal cord and the nerves which branch out  
from them. The brain is the seat of the mind  
and the spinal cord is the seat of the nerves. The  
nerves are made up of many small fibers which  
are called nerve fibers.



Text of the Nervous System.  
**Of the Nervous System.**

**I.** As the functions of Sense and motion which comprehend so many of the functions of the Animal Economy depend on the Nervous System, the study of this must be of the utmost importance in the study of the general Economy and its particular Functions.

**II.** In the study of the Nervous System it is in the first place necessary to learn what truly happens there, and this we shall think of more importance than to explain how it does happen. Upon this plan the following propositions are drawn up.

**A General View of the  
Nervous System.**

**III.** The Nervous System consists of the Medullary substance of the Brain, Cerebellum, Medulla oblongata and Spinalis, and of the same substance continued into the Nerves, and by them distributed to many different parts of the Body.

**IV.** The



IV. The whole seems properly distinguished into these four parts.

1. The medullary substance contained in the Cranium and vertebral cavity, the whole of which seems to be made under a fibrous arrangement, but without the several fibres being separated by any sensible invelloping Membranes.

(When we speak of functions that may be in common to every part of this we shall speak of the whole under the title of the Brain. When it is necessary to distinguish the particular parts we shall take care to avoid Ambiguity.

2. The Nerves in which the same medullary substance is continued, but here more evidently divided into Fibres, each of which is separated from the others by an invelloping Membrane derived from the pia mater.

3. Certain Extremities of these Nerves of which the medullary substance, for a certain length, is divested of these invelloping Membranes (2) and so situated as to be exposed to the action of certain external bodies, and perhaps so modified as to be affected by the action of certain bodies only. These we name the Sentient Extremities of the Nerves.

A. Certain Extremities of the nerves (2) so modified



fixed as to be capable of a peculiar Contractility, and in consequence of their situation and attachments by contraction to be capable of moving most of the solid and fluid parts of the body. — These we name the Moving Extremities of the Nerves; They are commonly named Moving or Muscular Fibres.

That the Muscular Fibres are a continuation of the Medullary Substance of the Brain and Nerves has not been shown by the Anatomists nor universally admitted by the Physiologists; but we suppose it now and hope to render it sufficiently probable hereafter.

Are the Ganglions of the Nerves to be considered as a part of the system distinguished by a peculiar Function?

V. These several parts of the Nervous System are every where the same continuous medullary substance, uniform in it's mixture and general aggregation, and therefore Motion may be propagated from any one part of it to every other while the continuous substance remains in the same condition.

Compression interrupts the Communication of Motion between the parts of the System that lie on different sides of the part compressed.



VI. In the living Man there is an immaterial thinking substance or Mind constantly present, and every Phenomenon of thinking is to be considered as an affection or faculty of the Mind alone.

But in the living man this ~~is~~ immaterial and thinking part of him is so ~~un~~connected with the material and corporeal, and particularly with the nervous system, that motions excited in this give occasion to Thought; and Thought, however excited, gives occasion to new motions in the nervous system. — This mutual communication we assume confidently as a fact, but the mode of it we do not understand, or pretend to obviate the difficulties that attend any of the suppositions that have been made concerning it.

VII. The Phenomena of the nervous system ordinarily occur in this order.

The Impulse of external bodies in motion acts upon the sentient extremities of the Nerves and gives occasion to Thought, and this we call Sensation. This Sensation according to its kind and various modification gives occasion to Volition or willing the motion of certain parts of



of the Body; and this Volition gives occasion +  
to the Contraction of the Muscular Fibres by  
which the motion of the part desired is pro-  
duced.

This is an Example of the most ordinary Case  
but we do not say it is the only case of Com-  
munication between the different parts of the  
Nervous System.

VIII. As the Impulse of Bodies on the Sen-  
tient Extremities of the Nerves does not occasion  
any Sensation unless the Nerve between the Sen-  
tient and the ~~Brain~~ be free from ~~other~~ Compression  
or other interruption; and as Volition does not  
produce any Contraction of Muscles unless the  
Nerve between the Brain and Muscles be quite free;  
we conclude from both facts that Sensation &  
Volition so far as connected with corporeal motion  
are functions of the Brain alone; that Sensation  
arises only in consequence of external impulse  
producing motion in the sentient Extremities  
of the Nerves, and this being then propagated  
along the Nerves to the Brain by a motion begun  
there and propagated along the Nerves produces  
the Contraction of the Muscles.

IX. From what is now said we perceive more  
distinctly



distinctly the different functions of the several parts of the Nervous System formerly distinguished.

1. The sentient Extremities are particularly fitted to receive the Impressions of external bodies, and according to the difference of these Impressions to propagate determined motions along the Nerves, which communicated to the brain give occasion to Sensation.

2. The Brain (IV. 1.) is a part fitted for and susceptible of these motions with which Sensation and the whole consequent operations of Thought are connected, and thereby or otherwise is fitted to perform a Communication between the motions excited in the sentient and those arising in the moving extremities of the Nerves, often remote and distant from each other.

3. The moving Extremities of the Nerves are so framed as to be capable of Contraction, and of having this Contraction excited by Motion propagated from the Brain and communicated to the Contractile fibre.

4. The Nerves more strictly so called are a collection of Medullary fibres, each invelliped into it's own proper Membranes and thereby so separated from one another



another as to admit of no communication of motion from one to the others, and only of Motion along the continuous Medullary Substance of the same fibre from the Extremities to the origin or converse-  
wise.

X. From this view of the parts of the Nervous System, of their several functions and communication with each other, it appears that the beginning of motion in the Animal Economy is generally connected with Sensation, and that the chief effects the Actions of the Animal Economy consist in and depend immediately upon the contraction of moving fibres, And therefore in studying the Nervous System it will be proper to consider

1. Sensation, and with that the function of the Sensitive Extremities.
2. The action of the Moving Fibres.
3. The Communication between these or the functions of the Brain.

In considering these three the Function of the Brain more strictly so called will of course be explained.

Of



# Of Sensation

**XI.** Sensation may in general be referred to the mind's being conscious of the changes which happen in the Nervous System.— But our Sensations may be considered as of two kinds, one arising from the Impression of External Bodies which we name Sensations of Impression; the other arising from the mind's being conscious of it's own actions, of the motions it excites, or of the like motions excited by other causes, and these we name Sensations of Consciousness.

## Of Sensations of Impression.

**XII.** The Sensations of Impression are very various, but have been generally referred to the five heads or classes commonly called the five Senses, that is those of Sight, Hearing, Smell, Taste, & Touch.

**XIII.** Of these the four first are well distinguished, each as forming a particular class or genus.

1. By the nature and qualities of the External bodies acting.

2. By the part of the Human body acted upon generally limited to a small space and connected with



with a peculiar Organization.

3. By the Sensations arising, in each very various, but at the same time referred to one Genus;— &

4. By this that the Sensation arising gives no Indication of the Nature of the External body acting nor of the mode of its action.

XIV. With regard to the fifth kind of Sensation, no such Characters concur in establishing one class, and is only formed by referring to this fifth head every Sensation that does not manifestly belong to the other four.

This head of Touch is, as commonly spoken of, found to comprehend

1. Sensations which arise from the Impression of Bodies of very different Natures, Qualities, and Modes of Acting.

2. Sensations from Impressions which may be made indifferently on any part on the Nervous System, and therefore on parts not connected with any particular Organization.

3. Sensations which have no such general affinity, as (XIII. 3.)—

4. Sensations which give such Indication of the Nature of the external bodies acting and of their Modes of acting



acting as we acquire in this manner only.

5. Sensations which may arise from Impressions made on any part of the System, but do not, any more than those of the four Senses give any Indication of the Nature of the Bodies acting.

6. Sensations arising from Impressions made on a particular part of the System only, and therefore depending on a particular condition or Organization of such part.

7. Sensations which are not of Impression but of Consciousness.

It is therefore necessary to subdivide & arrange what is comprehended under the general head of Touch.

**XV.** By Touch we perceive the Impulse of Bodies in motion, and thereby acquire our Notion of the force or Momentum of Bodies. — The Sensation is varied by the Direction of the Impulse and Duration of Impression, the number of the parts of the Body affected at the same time, or by their being more or less equally affected. It is thus we acquire the Notions of the Size, figure, and consistence of bodies; thus we acquire the Notions of Extension and Solidity inseparable from our notion of Body.

**XVI.** These are the Sensations most strictly refer-  
(ed



ed to Touch, and from these and from some other Considerations of the other Senses we conclude that all the Sensations are only so many different modes of Touch or Perceptions of Impulse. The sensations mentioned (XV.) may arise from Impulse or Pressure on almost any part of the nervous system.

XVII. It is owing to the Analogy mentioned in the last Paragraph, that so many different Sensations have been comprehended under the head of Touch.

XVIII. By the Impulse of External Bodies variously modified we receive the Sensations of Puncture, Pressure, Distension, Distraction, Contorsion, Laceration, &c. &c. — And like Sensations sometimes arise from internal Impressions whose mode of Impulse is not evident — May we conclude from the Sensation that the Impression is the same.

XIX. From certain external Applications of Bodies in a fluid form, distinguished by their chemical qualities and whose Mechanical properties are unknown, we receive in some Sensations resembling Puncture, Incision, Laceration, or other Sensations attending Solution of Continuity by mechanical powers; but in other cases the peculiar Sensations of Itching



Itching and Smarting without reference to any external Agent. These, tho' commonly referred to the general head of Touch may be considered as constituting a peculiar Sense of Chemical Acrimony. It is in common to the whole Nervous System only with different degrees of Sensibility as the Extremities of the Nerves are more or less covered by other parts interposed. The matters operating here are very often the same with those that produce Smell and Taste. — All of them are distinguished by chemical Qualities, and to their operation on these three Senses, the same Circumstances are necessary as in the mutual Action of Bodies of Chemistry.

From the Sensation of Puncture arising from chemical Acids may we suppose their Modes of Impulse to be analogous to that of the Mechanical Acids?

XX. The Sensations of Heat and Cold always referred to Touch, we consider as belonging to a particular Sense very different from that of (XV) in this respect that the Sensation gives no Indication of the Mechanical properties, or of the Action of the matter producing it.

XXI. In the Sensations (XIX & XX) and in some others attended with pain we hardly distinguish the peculiarity of the Sensation and attend to it as pain-fully



painful only.

XXII. Many Sensations are constantly attended with propensities, and therefore form a peculiar set of Sensations.

This is peculiar to them that very often we do not distinguish the Impression from the Propensity, and very often we are only conscious of the last. — These propensities are of two kinds — Some are directed to an external Object and are called Appetites, as those of hunger, thirst, and lust; others are directed to exciting motions of the Body itself only, chiefly for the purpose of Excretion.

The Sensations giving occasion to these several Propensities are often very little perceived, and it is often uncertain how they are produced, whether they are from external or internal Impressions, and whether they are Sensation of Impression or Consciousness. ~

## Sensations of Consciousness.

XXIII. The Sensations of Consciousness may be referred to these heads.

1. Sensations arising from the Diminution or Absence of Impression.

2. The



2. The Sensation of Apperception, or that by which we acquire the notion of our Existence and Identity.
3. The Sensation arising from the State of Thinking.
4. Sensation arising from the Exercise of Volition.
5. Sensation arising from actions or from the motions of different parts of the body.
6. Sensations arising from the state of Action in general or in particular. Under these heads a considerable number of Sensations are comprehended of which we cannot here enter into the detail.

## Laws of Sensation.

XXIV. The Impressions producing Sensation may be distinguished as external or internal. — The first are these of Bodies external or extraneous to the human body whether they act directly on the external parts or are conveyed into the internal and act there, and whether they are entirely from without, or are preternatural bodies generated or formed within. — The Internal Impressions are the Actions of the Body itself which reflect or return an Impulse on the Nervous System.

It is often difficult to distinguish the Sensations of Internal Impression from the Sensations of Consciousness. —



XXV. To Sensation from Impression a certain force of Impression is necessary, and below this no sensation is produced. This force is also limited on the other hand, as in a high degree it destroys the organ, and in degrees approaching to this rather a general Sensation of pain than any particular one is produced.

XXVI. Within these Limits our Sensations are not exactly proportioned to the force of Impression, but for the most part relative to the change that is produced in the Nervous System, so that a Sensation often seems strong or weak as it is stronger or weaker than that which has immediately preceded it. For the same reason the limits mentioned in (XXV) are very variable.

XXVII. Different Sensations do not necessarily imply a different kind of action producing each, but sometimes they arise merely from a different degree of force in the same.

XXVIII. It appears that the Diminution of the force of Impression is sometimes active with regard to the Nervous System, and therefore that the Motions of our System depend more upon Sensation than upon Impression.

XXIX. To Sensations from Impression a certain duration of Impression is necessary.



XXX If the force and duration of Impression are in a due degree, the Sensation often remains for some time after the Impression has ceased.

XXXI. The mind admits but of one Sensation at one time, so that of two Impressions made at the same time the one is only perceived, the other is not; or if the mind, as in (XXX) is occupied by a former Sensation, a present Impression is not perceived.

XXXII. The mind seems to be determined to attention by the force of Sensation, by the Pleasure or Pain arising from it, by the degree of Emotion or Passion produced by these, and lastly by these Emotions being more or less related to the person feeling.

XXXIII. Tho' the mind admits but of one Sensation at one time, several Impressions may act at the same time in producing Sensation, if they be such as can unite in producing a single Sensation. Such is the case when the Sensations which would be produced by separate Impressions are all of the same class or genus, as in the cases of Colour, Odour, Sound, and Taste.

XXXV. In each of these the Impressions correspondent to the several species can unite in producing



a single sensation, which is always a neutral or different from either of the separate sensations.

XXXVI. In all cases of such union it may take place, either when the Impressions are exactly synchronous or where the one succeeds the other before the sensation of the first (XXX) has ceased.

XXXVII. Tho' the motions excited in the nerves by Impression remain for sometime as in (XXX) they must be supposed to become continually weaker and at length to cease and therefore the sensation also.

XXXVIII. It is observed that the same Impressions soon repeated do not produce the same effects as before, but continually less; hence all new Impressions are, *ceteris paribus*, strongest.

XXXIX. Impressions being given, their effects are different in different persons and in the same person at different times. — This must arise from the difference of the bodies acted upon. — The chief differences occurring in these seem to be the following.

1. The State of the Teguments or other parts interposed between the Impressing Body and the Medullary Substance.

2. The state of the Medullary Substance itself



as appears in age, sex, and Temperament.

3. The State of Tension in the Medullary Substance by the blood vessels connected with it.

4. The state of it produced by Heat.

5. The state of it produced by former Impressions.

6. The state of the Nerves along which the motion is propagated.

7. The state of the Sensorium.

8. The State of Attention.

**XL.** Different parts of the Body are sensible by the Nerves distributed to them, and by the conditions [XXXIX] of these Nerves, but Anatomy does not always certainly determine the distribution of the extremities of the Nerves, and therefore the Sensibility of several parts is chiefly to be ascertained by Experiment. The Experiment is however also fallacious.

**XLI.** Particular Sensations arise from Impressions on certain bodies only.

1. Because the Sentient Extremities are so situated as to lie exposed to the action of certain external bodies only.

2. Because the Sentient Extremities are connected with an organ that encreases the force of the external



nal agent or modifies it in the manner most necessary to a determined Impression.

3. Because the fibres of the sentient Extremities by their size or Tension are fitted to be acted upon by certain external bodies only.

4. Because the sentient Extremities are by the Constitution preserved in a certain state that renders them sensible to a change.

5. Because the sentient Extremities have such connection with the rest of the system as produces particular effects from Impressions made upon them.

**XLII** Different Sensations are accompanied with different Judgements concerning the Bodies making Impression, and the part of our body upon which it is made.

Some Sensations are referred to external bodies at a distance, others to external bodies in contact, and others only to the feeling body itself. In the last case the Sensation is sometimes referred to the part upon which the Impression is made, with regard to external parts, very accurately, with regard to internal much less so, and commonly the Internal Impression or Sensation of it is referred to the correspondent external part with some obscure distinction

between



between internal and external.

In some cases the Sensation is not referred to the part upon which the Impression is immediately made, but to a distant more sensible part to which a motion is propagated from the part impressed.

Sometimes a Sensation is referred to a part from which Motions producing Sensations used to proceed along the Nerves now under an unusual Impression.

The Sensations of Consciousness are seldom with any Accuracy referred to particular parts and only indistinctly to a whole Membrane, seldom to external Agents.

**XLIII.** We are disposed to combine our Sensations as united in one object to form the notion of Individuals of Substance of Identity, and thus we acquire what we call Complex Ideas. The chief of these is our notion of self or our own Identity. The parts of Complex Ideas are associated.

**XLIV.** We compare our several Sensations and from thence acquire new Sensations of relation, the chief of which are those of Resemblance, Difference, and Contrariety of Position, in the Place and Time, of Cause and effect, of Means and Ends. It is especially relation that associates Ideas.

**XLV.** The



**XLV.** The most of our Sensations, nearly all of them, are either painful or pleasant.

**XLVI.** The terms of Painful and Pleasant, Agreeable and disagreeable are general terms comprehending a great many species to which the generic terms should not be promiscuously applied. — I think it may be proper to distinguish on the one hand the Agreeableness of figure, the deliciousness of taste, and the pleasure of venery — and on the other hand the disagreeableness of figure, the uneasiness of sickness, and the Pain of a wound. — There is a foundation for establishing different orders of these Sensations, but the fixing the limits between these and ascertaining the several species may be difficult, and we cannot be certain of applying the terms with strict propriety.

**XLVII.** In general Sensation and Action within certain limits are always agreeable, and therefore the want of Sensation, imperfect and indistinct sensations, are always disagreeable. In actions of every kind the Sensations of Debility and of Difficulty are always uneasy.

**XLVIII.** In particular Sensations, their being uneasy, pleasant, or painful, often depends on the degree of force in the Impression modified by the



*the Sensibility of the System.*

**XLIX.** As Impressions by being repeated give weaker sensations, Impressions at first painful may be changed into pleasant, and the pleasant into uneasy, hence the desire of variety, the pleasure of novelty, and the desire of increasing the force of pleasant Impressions.

**L.** There is a condition of Impressions rendering them agreeable or disagreeable which we cannot certainly refer to their force, and this condition we call the *Quality of Impressions*.

**LI.** Impressions are often rendered agreeable or disagreeable by combination, Relation, and succession.

**LII.** The force of Sensation is as—  
The Impression is new and unexpected.  
The Force of Impression.  
The Quality of Impression.  
The Sensibility of the Organ or Sensorium.  
The Habits of the System.  
The Pleasure or Pain accompanying it.  
The Emotion produced by it.  
The state of the attention.

— Several of these conditions ~~concur~~ concur, often balance one another, and must be taken together.

**LIII.**



LIII. When Sensations formerly received are again renewed by the same object, it is often with a Sensation or Consciousness of their having been formerly received. This we call Reminiscence. It is the chief foundation of our notion of Identity.

LIV. Notions formerly received can be renewed without the presence of the Object which formerly gave occasion to them, and if this is with a Sensation of a difference between the two notions and particularly of a Consciousness of the absence of the Object, such a renewed notion is called an Idea, and the faculty by which it is renewed is called memory. [I might have said, more strictly memory.]

LV. Notions formerly received may also without the presence of the object be renewed in such a manner that the Mind does not perceive the difference of the one case from the other, and therefore such renewal is always with the persuasion of the presence of the Object. The faculty by which such renewal is made is called the Imagination more strictly.

LVI. The causes of Reminiscence & Imagination are difficultly assigned. Memory we can refer to the Association which the marking of relations produces



produces, and it is faithful to that Association in all its circumstances.

**LVII.** Memory & Imagination renew distinctly only the Ideas of Seeing and Hearing. All others are renewed imperfectly or not at all. But all others may be associated with the Sensations or Ideas of Seeing and Hearing, & these become signs of the others, with this effect that the Memory in renewing the signs so far renews the Ideas connected with them as to make their several relations and associations to renew the general Idea of Pleasure or Pain that attended them, and particularly to renew the Emotions of the Mind or the Motions of the body, which they formerly produced.

**LVIII.** Memory is different in different persons, and in the same person at different times of life and on different occasions. The causes of this seems in general to be

1. Different States of the Sensorium.
2. The different forces of Single Sensations.
3. Different force of Relation; and
4. The more or less frequent Repetition of Sensations and of making their Relation.

**LIX.** Certain Sensations can be produced by different causes.



LX. No Sensations or Ideas arise originally in the Mind without a previous change in the state of the Body. Memory and Imagination renew only the Ideas or Sensations formerly received, and with the conditions expressed.

LXI. Certain Impressions and certain states of the Body analogous to the states which produce the sensations of Consciousness may both act upon the Nervous System without producing Sensation.

LXII. The moving fibres (IV. A.) so far as yet known are of one kind only, and the same every where as in the most commonly known Muscles; hence the terms moving or muscular fibres are of the same Import.

LXIII. A Muscular Fibre is supposed to have a particular Organization different both from that of simple solid fibres, and from that of the medullary fibres in any other part of the Nervous System; but in what that peculiarity of Organization consists is not yet exactly ascertained.

LXIV. A Muscular fibre is endued with a contractility which is different from that of the simple solids or other common Elastics, especially in this that its action is excited by causes which do not affect these others. It is excited by the Extension  
of



of the fibre, and a contraction is produced whilst the stretching power is continued to be applied. It is also excited by various applications whose mode of actions we do not perceive; but we know them to be such as do not affect common Elastics.

In respect of these causes by which it may be excited the Contractility of Muscular Fibres has been called Irritability.

Whatever excites the contraction of muscular fibres is called a Stimulus.

LXV. The force of Contraction in Muscular Fibres is often much greater than that of the causes exciting it.

LXVI. The Contractility of Muscular Fibres (LXIV, LXV) appears especially in living bodies, ceases with life or soon after and is probably never produced but with life; hence by some writers it is called the vital power of Solids and the solid induced it a living Solid.

LXVII. The Contractility (LXIV, LXV, & LXVI) seems to belong to Muscular fibres in some measure independent of their Connection with the other parts of the Animal System. This power of Contractility hath been with respect to Muscular fibres called a *vis Innata*, and we shall call it the Inherent power.

LXVIII. The



LXVIII. The Contraction of Muscular fibres can be excited by application to other parts of the Nervous system as well as to Muscles themselves, and as the effects of Applications made to other parts of the Nervous system can be prevented by Ligatures made upon the nerves between the place of Application and the Muscle to be moved, it is supposed that the Contraction of Muscular Fibres can be excited by a power communicated to them by a motion propagated along the Nerves. This power is called the Nervous power.

LXIX. The Nervous Power is most commonly determined to motion by the Will. This we suppose to cut in the Brain only and to depend upon Sensation and other Modifications of Thought. This power chiefly to be referred to the Mind and acting in the Brain only we call the Animal Power.

LXX. The Facility with which the Inherent power can be excited and the force excited by it in Contraction are to be distinguished. The first we name the Mobility, the last the Contractility of Fibres. Both have been confounded under the name of Irritability.

LXXI. The Mobility and Contractility of Muscular Fibres can both of them be increased or diminished by



by various means. The means of increasing the contractility of fibres are called Tonic powers, those that diminish the mobility of fibres are called sedative powers.

LXXII. The Inherent power is supposed to be stronger, more moveable, and more permanent in certain muscular fibres than in others.

LXXIII. The inherent power can be excited, increased or diminished by certain applications made either to the Muscles themselves or to the Nerves connected with them, and in either case the effects of the application is so exactly the same as to make us conclude that the matter in the nerves and muscular fibres is of the same kind.

LXXIV. The muscular fibres are sensible to various Impressions, and are otherwise Organs of the Sensations of Consciousness (XXIII. 6.) and from this also it is presumed that they consist of the same matter that is the subject of Sense in other parts of the Nervous System.

LXXV. From LXXIII, LXXII, and other considerations it is probable that Muscular Fibres are a continuation of the Medullary Substance of the Brain and Nerves as alledged (IV. 4.)—

LXXVI. Tho' the Muscular Fibres consist of the same



same kind of Matter as is also in the Nerves, the latter shew no Contractility because they are not under the same circumstances and have not the peculiar Organization of the former.

LXXVII. The Nervous, (LXXVI) and the Inherent, Power (LXXVII) may subsist for some time without any connection of the Nerve or Muscle with the Brain, and they subsist also in entire bodies for some time seemingly after life has ceased. Both powers however are seemingly of equal duration in these respects, and neither power seems to subsist long but in entire and living bodies.

LXXVIII. In entire and living Systems the inherent power seems to have a considerable dependance upon the Nervous, and both perhaps have a dependance upon the Animal. (LXIX).

LXXIX. The Contraction of Muscular fibres does not depend immediately on the motion of the blood.

LXXX. The Contraction of a Muscular fibre does not depend upon the Inflation of Vesicles or other such Analogous Structure.

LXXXI. As the force of Cohesion in the Muscular fibres of living Animals is much greater than in those of dead ones, it is probable from this and other considerations that the causes of Muscular Contraction



=tion is an increase only of the same power that causes their contraction as simple solids.

If this is true, that the power of muscular contraction is an increase of the muscular fibres, it will explain why the force of cohesion of muscular fibres is greater in any other parts of the Nervous System, tho' both kinds of fibres by LXXXV consist of the same kind of matter.

LXXXII. In living & healthy Animals the Muscular fibres have a constant tendency to contraction, and this is what we call their Tonic power.

LXXXIII. The tonic power of muscular fibres necessarily supposes their being a constant state of extension, and as the extension of muscular fibres by LXIV proves a Stimulus to their contraction, we suppose that the Tonic power will, ceteris paribus, be in proportion to the degree of Tension.

LXXXIV. The muscular fibres are kept constantly in an extended state, by the action of the Antagonist muscles, by the weight of the parts they sustain, by the fluids distending the Cavities they surround, and by their Connection with such distended Cavities, particularly the blood vessels.

LXXXV. If the Inherent power, as in LXXXVI is in Dependence upon the Nervous and Animal powers, and



~~muscles~~ and these may be increased or diminished by various causes, the Inherent Tonic power must be in some measure in proportion to the Nervous and Animal powers.

LXXXVI. The force of Contraction of Muscular fibres will be always as the force of Stimulus, and the strength of Nervous, Animal, and Inherent powers taken together.

LXXXVII. The mobility of Muscular fibres seems to be increased by whatever weakens their Tonic power, and therefore by the diminution of their Tension LXXXIII., & by weakening the Nervous and Animal powers LXXXV.

LXXXVIII. If the Tonic power of any Muscular fibre depends more upon their tension than upon the Nervous or Animal powers, such fibres will be more affected by changes of Tension than by Stimulant, tonic, or sedative powers; and on the contrary, if the Tonic power of any Fibres depends more on the Nervous and Animal powers, such fibres will be more affected by the changes in the state of these powers than by the changes in the state of Tension.

LXXXIX. The ordinary Contraction of Muscular fibres is disposed spontaneously to alternate with a relaxation or extension of the same.



XC. In the straight muscles & in the Heart the alternate Contractions and Extensions readily appear even tho a Stimulus is constantly applied, but in other Muscular fibres surrounding cavities as in the alimentary Canal, bladder of Urine &c, the alternate motions do not appear, unless a portion of the Fibres is cut out and separated from the rest.

XC.I. From the different state of muscles contracted by inherent power, while the member they sustain is moved by external force, from that of the same muscles contracted by the Power of the Will, we perceive that there may be a state of Relaxation in Muscles without their Extension.

XC.II. When Muscles acted upon by preternatural causes are contracted with unusual velocity and force, and especially when such Contractions are alternating with Relaxations and Extensions frequently repeated, such motions are called Convulsions.

XC.III. There is a state of Contraction of Muscular fibres that is not disposed spontaneously to alternate with relaxation, and in which the fibres do not easily yield to attending powers applied, such a Contraction is called Spasm.



XCIV. If the Contraction of Muscular fibres is exerted with much force and such Contraction is frequently repeated, or even if with a Moderate force the Contraction is frequently returned for a certain time, the Contraction becomes uneasy and weaker.

But within these bounds of Force, Frequency, & Duration, the Contraction of Muscles by being repeated is performed with more <sup>facility</sup> ~~facility~~ and force.

XCV. Are not the Contractions produced by the Action of the Animal power these which are more especially liable to become uneasy and weak by repetition?







*Of the*  
*Nervous System.*

*Part 1.<sup>st</sup>*



# Of the Nervous System

We now come to the Nervous System.

(N.B. The Numbers refer to the Syllabus; & what follows are Comments on, or Explanations of, the several Heads.)

I gave you many reasons for placing the Nervous System here. I introduced the Subject by shewing the dependance of all the parts of the Body on the Nervous System.

There is no Situation more disagreeable than that of a Professor who is teaching Pupils who are averse to learning his Doctrines from thinking them of no consequence, or impossible to be learned &c.

These prejudices you may have raised yourselves or received from others; wherefore Proposition I.<sup>st</sup> is to remove the Prejudices against the Nervous System, & to engage your Attention to a Subject of considerable importance. The Functions of Sense & Motion comprehend most of this Economy. Those of Sense are the Functions by which we are conscious of the action of other Bodies on ours, & ours on them. These



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These, viz the Functions of Sense, are the means of our Communication with all external Objects, & these depend manifestly on the Nerves.

Most of our Motions depend on the Action of Muscles, & these again are dependant on the Nerves, & further we find the Nerves are actuated by the Will, & the next step is that Will is actuated by Sense. Now if most of the external Motions depend on Muscles, most of the internal depend as certainly on the same. The action of Muscles in all cases depends on the Nerves & therefore the Functions of Sense and Motion depend on the Nervous System, that is to say, have a connection and dependance on the Nerves, wherefore must depend on causes acting on the Nervous System. Surely then if we are to attempt an explanation of this Subject we must attend to this in particular as it is of the utmost importance in the general Economy. The Functions I speak of are these by which Life begins. I give always at first what is to govern my Plan & therefore do I here give you the Nervous System. It may, & often has been, said that we cannot give this



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Doctrine the perfection we wish; but if we would attempt Physiology at all we must go on as far as we can.

In this there are difficulties, but I hope a little Patience & regular Attention will remove these. Many Physicians have suggested to themselves difficulties never to be overcome, such as the connection of the Soul & Body: surely we cannot in this life explain how Spirit acts on the Body, which is a desperate Problem, but we can observe upon a hundred occasions the Laws on which it depends tho' we may not perhaps be able to acquire a knowledge of their Nature, & altho' we do not arrive at such ultimate perfection we may come to many general Conclusions, which will be of the utmost service in the Practice of Physick. Thus the Alchemists, altho' they have never attained their end of finding out the Philosopher's Stone which they had in view, yet in the course of their pursuit they have made many discoveries <sup>ch</sup> which are of great Importance both in Physic & every other Situation of Life.



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II. I have in this particular explained my Plan.

The first step in all Sciences is to ascertain the Phenomena & to say what does happen; for the first Step in Philosophizing is to unite a Number of particulars which have something in common to them all, & a number of such particulars form a general rule, or rather a general Fact only, & thus, by generalizing particulars, we proceed to more general Laws. This Progress depends on the Number of the Particulars we have known & marked, which is Induction; and therefore our progress depends upon the Number of Facts we collect, or the extent of our Induction. Our further Progress will always be greater as we have made more Progress in the first Step. We naturally infer Causes & proceed on a short Induction: When we do this in search of general Laws I call this an Hypothesis; which is allowable if we admit them to have a place with a view to future correction, & if they unite with other things in our general Laws. I shall be satisfied if I can give you a large Stock of Facts. I may presume you will generalize & investigate where I cannot.

Lord



# Of the Nervous System.

Lord Verulam observed "Non eacogitandum sed invenirendum quid Natura faciat aut ferat." While I acknowledge this Maxim I have constantly found that a bare enumeration of Facts, simple & solitary, can never engage the Attention. A Man must generalize, he must form Hypotheses, & this is not to be condemned if he rejects or confirms them by comparing them with as many Facts as possible.

The meaning of my Expression here is not that I shall exclude general Laws, but I shall proceed cautiously in generalizing Facts, & shall last of all attempt general Causes. I caution you against indulging causes, & I shall keep the Doctrine of such causes out of sight as long as I can, because the adopting such general Causes is too natural to young Persons of any Ingenuity & therefore I would advise you to guard against such propensity. I will not be answerable for Persons that will not go on my Plan. If they will adopt Causes rashly & take them on my word it is not my Design. — I have given you the Heads in writing, but I have not given them the perfection I could wish. In the meantime I am confident they will be useful to you; but neither  
you



# Of the Nervous System.

you nor others are to judge of them till I have added the explanations, when you will see why certain Parts are seemingly superfluous, others seemingly defective.

The Nervous System is fundamental with respect to the chief of the Animal Functions, & without it the whole of our Labour would be useless. We can attain to a great deal that is useful & applicable, & particularly to the Pathology. Tho' it lay long neglected yet the Importance of it is universally perceived, & it is every Day entered into more & more. The latest Writings, & perhaps some of the most useful cannot be read without it. My Design, I said, was first to obtain Facts that relate to it; we shall farther I hope ascertain many of the Laws, & I shall attempt the Investigation of Causes with Diffidence.

I propose first to give you a general Idea of the Nervous System that you may have a view of the relation and connection of the several Parts, & that is necessary to us in order to determine the general Order & connection; but I cannot enter into the Proof nor into the full Illustration. I will presume on your knowledge of Anatomy to render it at present merely probable.

The



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The Limits of the Nervous System, but take this for the first Idea; if any part of the Animal System is indued with particular Properties it were a presumption that it is peculiar in its Matter & Organization, & from the Extent of that Matter we may presume as to the extent of the Properties: If I find Medullary Substance indued with peculiar Properties in the Brain I will extend the application & suppose it to be the same wherever I find the Medullary Property; & when I see these Properties, I will conclude for the Existence of the Matter. Thus the Argument will be inverted.

III. The Medullary Substance consists of the cerebrum & Cerebellum, Medulla Oblongata & Spinalis, & the same Substance continued into the Nerves. An ingenious Physician asked me how I knew the Medullary Substance of the Brain was continued into the Nerves. I think it is a fact universally admitted by Anatomists, & I assume it from their Authority. The Nervous System exists wherever we find the Medullary Substance.



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IV. The whole may be distinguished into four Parts known by certain circumstances peculiar to each & different from the rest, & it will imploy perhaps a difference of Functions from which last we at present abstract.

1<sup>st</sup> The Medullary Substance contained in the Cranium & Vertebral Cavity I consider first as one Portion because it is uniformly of the same Matter in Colour & Consistence & because it is every where continuous & every Portion contiguous & continuous with another Portion of Medullary Substance. The whole seems to be under a fibrous Arrangement, tho' it is often a soft tender Mass without any such Appearance, but by a certain Preparation of the Fibrous Texture can be rendered more evident in some Animals, as in Fish. This Fibrous Texture is seen much clearer in the Brain of other Animals; but we cannot observe in what Manner the Fibres are kept distinct from one another, & we cannot discern a membranous Substance involving them. There is a slight Matter here if it were but to serve as an Example how Difficult it is to obviate every Difficulty. I have distinguished the Medullary Substance



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of the Brain by not being separated by an enveloping Membrane, which last enters so far into its Substance from the Nerves. It has been often called the Sensorium commune, which we reject because we want to consider it as concerned in other Functions besides Sense.

We mean by Sensorium an active Function exciting Motion. It has been termed the common Origin of the Nerves, but that is a long Description. I shall speak of it under the Title of the Brain, which I mean when I speak of Functions that may be in common to the whole, or of which we cannot assign the particular Seat. There may be occasions where I shall inquire how far the Brain & Cerebellum are distinguished by Functions from the Medulla Spinalis. I shall speak of it more strictly; but, when I speak of Sense as one Function of the Brain, I take the Brain in its extended Signification.

2. The second part of the Nervous System is what we call the Nerves; where the same Medullary Substance takes



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takes place, but more evidently divided into Fibræ, and each Fibræ is separated from every other by its own enveloping Membrane divided from the Dura & Pia Mater.

The Nerves are generally chords of a considerable evident size & in general divisible into a Number of smaller Chords; but the whole of every Fibræ that we can subdivide has a firmness greater than the Medullary Substance, & that from a dense & firm Membrane that incloses the soft Substance, & this covering is from the Dura & Pia Mater; but from which of the two Membranes or from both is immaterial. The Subdivision of all the larger Nerves is evident, as well as their being enveloped in their own Membranes, & whether we can very minutely divide them or resolve them into their smallest Fibræ is needless; but there are circumstances which will appear afterwards: We presume then upon that.

Now, where the Medullary Substance is separated into distinct Fibræ, & where especially it is to enter the Nerves, we can observe these Fasciculi of Fibræ before they are closely embraced by the Pia Mater. Another Portion is stripped of these enveloping Membranes. The former I only call Nerves, & this is the foundation of what follows.



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3. A third Portion of the Nervous System may be said to consist of certain Extremities of Nerves that are divested of their Membranes; and they are further distinguished as exposed to the action of particular Bodies & so modified as to be affected by the action of certain Bodies only. When a Body is drawn out into length it is continued to a certain length & discontinued into length it is continued to a certain length & discontinued, and not discontinued at the other End; the former only I call Extremity. I do not mean merely the extreme Point, but a certain portion towards that extreme Point; but it is divested of its Membrane and exposed to the action of certain Bodies. The Retina is the Extremity of the Optic Nerve; which, as it is expanded within, we suppose it divested of these Membranes, and it is not exposed to the action of Bodies conveyed in the Air, and floating in the Nose, or to various liquids acting on the Tongue, but it is exposed to the Impulse of Light:—perhaps we should have said it is exposed to the action of certain Bodies transmitted to it by other Bodies. The Retina is placed between Bodies that collect the Light & reflect it on the Retina. The Ear is affected by the Motion of Air in Sound, and it is joined to an Apparatus that modifies the Motions of the Air on which Sound depends.

Probably



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Probably, besides these two circumstances, they are also so modified as to be determined to be affected by the Action of certain Bodies only, or at least by the Action of certain Bodies more than others. These Extremities we name Sentient Extremities, as we have in most Instances certain Ideas in our Minds in consequence of the action of certain Bodies, and some of them are the means of one Sense and some of another, but I do not mean to exclude the whole of the Nervous System from being in some Measure an Organ of Sense; but, as certain Organs are more readily and especially so, we make this Distinction.

4<sup>th</sup>. Here at present an Hypothesis enters into our Enumerations.

Most of the Motions of the Animal Body we can refer to Muscles, which are subdivided into a great Number of distinct Fibres. The Contraction of the whole Muscle, the drawing of its Tendons, depend upon the Contraction of each of its Fibres. These we call Moving Fibres because we do presume that in every Part of this Animal System where there are Motions they depend on Fibres like what we see in evident Muscles.

They



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They are so modified as to be capable of a peculiar Contractility. Their Modification is still a doubt among Anatomists, but as they have peculiar Properties so they consist of a peculiar Matter or Organization. We shall speak of the Matter just now. We give a Mark of their Contractility, <sup>†</sup> if their Contraction may be excited by Powers that we do not know to act upon any other Fibre so as to give this effect of Contractility. It is therefore peculiar to this part of the System. They are capable of moving most of the Solids, & fluid Parts of the Body. We call them a continuity of the Nervous Extremities of the Nerves, or part of the Nervous System, & a part of the Medullary Substance. But the only difficulty follows, for that the Muscular Fibres are continuations of the Nerves is not proved by Anatomists, nor universally admitted by Physiologists (Vid. part 4.<sup>th</sup> Prop. 4.<sup>th</sup>.)

The Muscular Fibres are acted upon by Powers applied to the Nerves & you will see that it is no great stretch of our supposition to make them just now Extremities of the Nerves; but we hope to prove that they are continuations consisting of the Medullary Substance. All



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All these four Parts then are at bottom formed of Medullary Substance & observe how they are to be distinguished from other parts of the Economy. I distinguish the Brain from the cortical & vascular Part. I exclude all these Parts of the Organs of Sense that are only contrived for modifying or admitting the action of external Bodies.

The Vitreous or Aqueous Humours, the Crystalline Lens, the several Muscles that move the Eye, considered as giving the Motion of the whole Organ, are no parts of the Nervous System. We further exclude Tendons moved by the Muscles which have not the properties of the Nervous System, but I am not to explain the structure of these excluded Parts, nor am I to explain their Actions.

We are to exclude a fifth Part, the Ganglions; for their Balls are no doubt of certain Use & Purpose: Whether it is a Function to be distinguished from the other Functions of the direct Course of the Nerves is the question. Some have called them Vicarious Brains & they have assigned several Uses to such a Function.



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An ingenious Gentleman has observed that they are to be found in certain Nerves only & that they modify the Functions of the Brain, but if they have a Function we do not yet know it & they serve no other Functions but the mode of Distribution for any thing we know.

It is intended that every difficult Viscus, Muscle &c, should have Nerves both from the Brain & Spinal Marrow. I do not say whether Muscular Fibres are without, or with, their Membranes. They are capable of Contractility which we do not see in any other portion of the Membrane.

V. That there is a Medullary Substance I hold you my reasons for thinking.

Nobody has suspected that in any part of the Nerves their Substance is intercepted. The Uniformity is probably in the Nerves as in the Brain. It is evident in the Sensitive Extremities & in the others so far as we can see them. Considering the Medullary Substance as a mixt, composed of different Parts, there is no doubt of its uniformity, & from its uniformity of Functions there is no doubt of the sameness of



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of Mixture. General Aggregation is the arrangement of  $\frac{c}{y}$  integral Parts of a body with regard to one another in opposition to the larger Parts. Concretion is the same with general Aggregation. In the Trunk of a Tree the Wood may be said to be uniform, & yet it is of greater density in the Middle & less so as you come towards the Bark: that is but an inconsiderable difference, & if there should be such a difference of Density in the Medullary Substance it does not disturb my Conclusion that, in consequence of Continuity, Contiguity, and Uniformity, Motion may be propagated from any one part to every other; & it will continue to do so while this Contin: remains in the same uniformity. I do not mean here to anticipate any Opinion on this subject. The Communication may be first from the Fibres being hollow & containing a fluid in motion from one part to another: This I do not mean to exclude, nor the second Opinion that the Nerves are supposed to be in the circumstances of Elastic Chords, & so propagate Tremors from ~~one~~ one part to another, nor the third that the Nerves are not elastic Chords, but that they convey a subtilo elastic fluid that is the cause



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of Motion. All that I mean is that Motion may be propagated from any one part to any other, & the fact is probable there may be a Motion propagated from the Nervous Extremities to the Brain. Some Doubts may arise with regard to the application of this, but these we are not ready to discuss.

V. I have added while the Continuous Substance remains in the same condition the Uniformity is not perfect, nor absolute perhaps. By Disease or external violence it may be changed, as by Compression: Take a Nerve & pass it between your Finger & Thumb or make a slight Ligature on it, by this all Communication is intercepted. This applies to the Nerves in several parts of their course & to the Brain. I will not say that this is the only means of Interruption; but I have introduced it to have an Opportunity of saying that the Nervous Communication is interrupted. I must enter a caution; I mean to express a general effect, but not to inquire the cause of it. Nothing is more intelligible upon the supposition of hollow Canals than to see that the Compression may interrupt the Motion, but it is no certain proof; there are Instances of Compression interrupting the Communication



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Communication of Motion upon the supposition of elastic Chords. In elastic Chords by compression of any part we can at pleasure determine the length to which their Oscillation shall extend: hence in a Fiddle we get different Tones by different lengths of Chords.

Here we anticipate no part of such Opinions. It is justly questioned if these Motions are mechanical & not owing to other powers.

VI. Now this proportion as here enumerated applies equally upon every Supposition we have formed of the Connection of Soul & Body. I need not explain what I mean by a living Man. I may be doubtful whether a Man is living or dead, but for the most part we are clear, tho' at times liable to deception. I do not neither say with Thinking is a simple Sensation not to be defined.

Descartes, seeking a fundamental Truth to set out within his reasonings, built upon this "Cogito ergo sum", but this Thought must be trusted to every body's feeling. As the Nervous System is connected in a special Manner with the Mind or Soul, & as various Opinions regarding that



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that Connection have entered into our Systems of Physics I thought it proper to explain myself here to prevent interruptions hereafter.

I propose then to give you a view of the different Systems on this Subject. The first is that of Stahl. It does not matter how ancient it is. It is constantly ascribed to Stahl & from him I take the Account.

The Human Body according to him is a Matter of a peculiar kind & has a particular Fabric. It is a Machine capable of certain Motions from its structure only, but it has in itself no activity or power of Motion. It is not even such as to have been put in Motion by another hand, nor of itself to support the Motions it recd, in the manner of a clock. Further it is not even a Machine that the external Powers are acting upon it & renewing its Motions can with such means have its Motions kept in subsistence. The whole Activity depends on the Soul that is somehow combined with it. You will have the fullest Account of the Stahlian System from Junker in Tab. 5. of his *Physiologia* "Corporis Motor est principium inorganicum sapiens intelligens"



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intelligens". The Activity of the living Man depends on the Soul, which last is so present in the Machine that it is, I would say, conscious of the state of the Machine & of its Changes, & not only of the action of external Bodies on it, but of the state of the Motion of the Solids & Fluids. With this consciousness it is attentive to the Machine's preservation, & on its guard against Interruptions of its Motions, & all this is a piece of Intelligence.

It is independant of any necessary influence in the Body; according to this its Attention, its Willingness, & Wisdom. It regulates the Motions of the Machine in Health & Disease. I shall give an example; The Machine is particularly liable to be overloaded with Fluids, to be plethoric, which interrupts the Motions of the Body; & further the Interruption is liable to excess, & therefore the Soul excites Haemorrhages to throw off the superfluous Load.

Many other Instances of the same kind occur in the several Congestions. Motions may not always be the best for the purposes of the Economy.

Abundance of Serum occasions the Haemorrhoides alba; see what he says "Ipse Natura ejicit". You will see



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see in this Author & in other Stahlian Writers a hundred such Instances. I will give one or two of Diseases happening from the Souls neglect altogether. In Chapter de Motuum Vitalium de-  
factu he says,

Pro causa &c

Omittat.

Also in the case of Apoplexy.

Reperitur.

I go on next to the System of D.<sup>r</sup> Whitt. To understand which, suppose any Number of Balls, say twelve, are so situated that if put in Motion they must move in a circle, if the hand puts one of these in Motion it will strike the 2<sup>d</sup> & impart Motion to it, the 2<sup>d</sup> will strike the 3<sup>d</sup>, & so on will the Motion be propagated thro' the Balls till the whole are put in Motion & the 12 will again strike on the first & communicate Motion to it. Now, if in each of these Balls the Motion had the same Momentum, the Motion would be perpetual at least for the ordinary Life of Man.

But in all Communication of Motion there is a loss of Momentum, the consequence of which would be Rest.

Upon this Demonstration turns the Impossibili-  
ty



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ty of a perpetual Motion; but, if there is, it may be supported in this Way; my hand which set the first Ball in Motion may be capable to perceive the Degree of Momentum in the Balls, and may regulate it so as that when it begins to fail it shall be kept up & continued for any length of time. His notion then is that there is an appearance of a sort of perpetual Motion in the human System. The Hand he supposes is the Soul, & the effect of it is the powers of Mechanism. This is the first part of the Stahlian System. It does not form a purpose & intention to renew these Motions, but its renewal of them is a necessary consequence of their endeavouring to cease. But the Sensitive Principle is so connected with the Machine that its renewing Motion in the latter is as necessary a consequence as if the Machine were a perpetuum mobile, or otherwise its Motions would fail. Take his own Words Page 73 of the 8.<sup>th</sup> Edition of his Nervous Diseases. Nor can we so receive the Mind

another Word 2<sup>d</sup> Edition Oct. on <sup>Action, and takes</sup> vital & involuntary Motions.

He



See Institutions Page 606



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He supposes if a Heart cut off of the Body were to act, it is only in consequence of the Sentient Principle being present; tho' the Sentient Principle may be necessary to give the Power yet it has no choice but is determined to certain Actions by an ungrateful Sensation or Stimulus, as much as if no such Sentient Principle were present; hence if I know the nature of the Stimulus applied I know what will follow; whether the Stimulus acts on the Sentient Principle or merely by mechanical Powers.

D.<sup>r</sup> Boerhaave agrees with D.<sup>r</sup> Whytt in the last Proposition, that the several Motions of the Soul are dependant in the 1<sup>st</sup> place on the state of the Body. He was zealous to maintain a rational Soul or sentient Principle, but he allowed that the Motions of the Soul were accompanied by a determined State of the Body. We have then only to observe <sup>the</sup> connections between the several corporeal Motions. He has not said what the Soul has to do in this affair; whether he thinks with Stahl or Whytt.

D.<sup>r</sup> Gaubius has been more explicit on this head  
(Page



*On the Sensus Interni.*

*To this Notion he alludes in Page 575*

*See from Page 570 & on.*



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(Page 523, 524.) Gaubius thought perhaps that Boerhaave's & Whytt's Opinions led to Fatalism. He therefore thinks that the Mind can, (pro lubitu) without any Motion from y<sup>e</sup> Body, give Motion to the Body.

D<sup>r</sup>. Haller supposes a Contraction may take place from the very Mechanism of the Fibre itself. In y<sup>e</sup> 569 Page towards the latter end, he has obviated the tendency the Opinion of Boerhaave might have to Fatalism.

D<sup>r</sup>. Whytt supposes a Muscular Fibre does not contract but on account of the Sensitive Principle.

With regard to all these Systems we are not now to enter into the controversy, whether right or wrong: We shall proceed on the last, especially Gaubius's.

We are to seek for the Causes of Diseases only from the corporeal Motions we can perceive taking place.

It is undoubted that the action of the Soul



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Soul has a considerable Share in the Actions of our Body more than mere mechanical Powers as Haller alleges.

In many Parts too the Soul is free, as in Morals or Sentiments, and can begin Motions, & vary & direct them: so that it is not according to D.<sup>r</sup> Whitt.

The Materialists, whilst they take notice of the dependance of the Soul on the Body, go farther, & derive the whole actions from material Principles. We absolutely reject it. Haller has sufficiently refuted it. It is difficult to speak on this subject without Ambiguity; that is, in speaking of such actions of the Soul as depend on the Body we may appear to favour the Materialists. It will however admit of the other meaning, & tis thus we are always to be understood.

In the VI I have endeavoured to avoid it as much as possible.

We



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We maintain that in the Animal Economy the part of thinking cannot be simply the result of matter and motion, but necessarily refers to the presence of an Immaterial Soul. In the living system these two principles of Soul and Body are so connected that the motions of the Body give occasion to the motions of the mind; and very generally motions of the mind are accompanied with certain motions of the corporeal parts, and corporeal motions are so linked together that they may produce motions on each other independant of the soul.

When we speak with a view to a system of Physic we add that tho' the common actions of the system be corporeal, yet if we see others superadded, it may be said to come from the soul, which is independant and free of the mechanism of the Body.

We come now to the connection and mutual action of the several parts of the Nervous system.

**VII.** This is the ordinary mode of operations in the Nervous system. I shall explain it by an example.

My eyes are opened in a Flower garden - The Rays of Light are reflected to my pupil and strike the Retina, and immediately there arises a sense of colour. This Sensation which arises is Pleasant. I desire



Haller's *Primo Linea* § 556.



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to enjoy it more fully, and bring more near to my eye the object (or Flower). This makes me will to stretch forth my hand, by which means the bending the body (if occasion requires) and plucking the flower follows.

In the same manner the Effluvia strikes the sentient extremities of the Nerves in my nose, & if disagreeable determines my hand to put away the Flower.

Here for the first time occurs the term Sensation. No difficulty can occur but from using the term Thought, because this has been employed by Metaphysicians, commonly, to signify the recollecting or effecting any operation. They have divided it into 3 terms, Perception, Intellect, & Volition. But it is necessary to have one word to express them all, and therefore I have used the term Thought.

Sensation then is Thought arising in the mind from a previous change in the Body.\*

Mr. David Hume is the first who has properly defined the difference between an Impression and an Idea. Mr. Locke has used the term Idea in too extensive a light — The Sensation we receive from a present object <sup>Hume</sup> ~~is~~ <sup>is</sup> called an Impression.  
That



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That which I receive from Recollection, an Idea, But I have not called this head of Ideas an Impression here, because it does not convey all we would mean by it; and we shall have occasion to make use of Impression in a different sense afterwards.

Volition may perhaps arise spontaneously in our minds, but I do not say that this is the only means of Sensation, nor of Communication, for I think there may be a communication between several parts of the Nervous System without Volition, or even Sensation, accompanying them, and may proceed from a Mechanical Cause.

**VIII.** The chief Communications of the Animal System are by and with the Interposition of the Brain, <sup>which is, so far as connected with Corporal Motions,</sup> Sensation, & Volition; ~~the latter~~ belongs to the brain alone. We have said before that no Sensation arises unless the Communication be free & uninterrupted. These are Propositions however which we cannot now enter into a full proof of. - We shall just mention the case of Ligatures. If any external Object be properly reflected on the Retina, yet if the Optic Nerve be compressed by a Tumor, all Sensation is



# Of the Nervous System

is destroyed in the part. The same happens in the case of a ligature on any of the Nerves of the Extremities.

Sensation of the will is always in consequence of an operation begun in the brain - Sensation then and volition as far as they are connected with corporeal motions, depend on the Brain and it alone.

The Stahlians consider the Soul connected with every part of the Body. Others that it is only connected with the nerves; but here is a difference of opinion too - Some say it lies only in the sentient Extremities of these nerves, whilst others maintain that it resides in the whole of the Nerves: But, contrary to both, we maintain with Gaubius that the Soul is only properly connected with the Brain, the immediate Organ of the Soul.

Having thus marked the particular share the Brain has in the nervous System, I go on to establish the mutual connection by means of its several functions.

**IX.** 1. Impressions are different in degree & motion, and these communicated to the brain give different Sensation; the Occasion of which Sensation



## Of the Nervous System

Sensation is communicated to the Brain by these motions. I do not say with the materialists, that they give occasion to Thought.

2. By Brain &c. Here by inserting the words thereby or otherwise, I have not excluded entirely any system, neither that of Stahl nor Gaubius, not but what Dr. Whist may be right. Independent of Sensation & thought, the Brain may be a means of communication, as in the case of Sympathy, which is not in consequence of any communication of Nerves, but only in consequence of reaching the Brain and thereby propagating to the parts affected.

3. I mean here to admit to a certain length the vis insita of Haller, but have taken care to add that it is confined to muscular fibres, that is if it be propagated from the Brain, it acts only on the contracting Fibre, not by a nervous power but in consequence of something communicated to the contracting Fibre.

Here I want to give a more strict notion of nerve than is commonly taken; As soon as the Medullary Fibre is collected into a Fasciculus, and surrounded by a proper membrane we call it a nerve, and as long as it keeps that cover-

ing;



# Of the Nervous System

ing; but whilst in the Brain before they receive that covering we call them Brain tho' divided into Fasciculi, and after this is laid aside we call them the Sentient or Moving Extremities. It is rather from Inference than direct Observation we perceive this part is different from the rest.

A. The most common opinion of Physiologists is, that the sensations of the nerves are in different directions. That of the nerves of sense from the Extremities to the Brain - of will from the Brain to the Extremities. But you see is different. We admit it as a proposition here, which we hope to make sufficiently clear hereafter.

The beginning of Motion is generally connected with Sensation. —

X. By chief Effects are meant the ultimate or chief ones of the Animal Formation.

In entering on Sensation we shall be unavoidably led into Metaphysical Arguments, but those are often subtle, and subtle reasonings are liable to Fallacy, but they will be sometimes absolutely necessary. — Metaphysics is marking how we form our first Judgements and proceed in our after intellects. To arrive at any length in gene:  
ral



## Sensation

nal Science they are unavoidably necessary. From the view we have already taken of the Nervous System we cannot proceed one step, without taking a view of the operations of the Mind so nearly connected with it. When I say then that I cannot avoid them, I will be on my guard against the Fallacies they lead to. - I now go to Sensation

**XI.** No mode of matter could produce this unless aided by the Mind or Soul. The chief parts of Sensation must be referred to the Mind, and distinct from the action of external bodies upon it. I would include too the share the body has in it. No Sensation happens in the Mind only in consequence of a previous change in the Body.

Mr. Locke has sufficiently proved the non-existence of Innate Ideas. And that Ideas arise only in consequence of the action of external Bodies on our different Organs of Sense. - Thus a man born blind has no Ideas of Colour - one born deaf none of Sound - and so on of the other Senses and all our other Ideas. They arise then first from evident, or (if we reason from Analogy) from supposed changes in our Bodies. But now I speak of Sensation, only, distinguished from Ideas



# VI.

The 2d Chapt: is here referred to, the out  
of the order in the Syllabus.



## Impression

Ideas.— With regard to Ideas we imagine the Spontaneity of the Mind may take place, but Sensation we think must depend on the Body.— The Mind is conscious of changes in the Body, but only as they happen in the Nervous System.— Stahl thought the Mind was present in all the Body, we in the Nerves only.— May we go so far as to say it is in consequence of changes in the Brain alone that all our Ideas and Sensations arise. This can be only mentioned as a Proposition here, which remains to be proved in the sequel.

Sensation then is of two kinds, of Impression and Consciousness.— and first of

Impression. You must observe that we give this name to any body which can be considered as external to the Nervous System, whether without or within the Body, and this gives rise to a distinction of Impressions as external or internal And 1.<sup>st</sup> External ones.

XXIV. These may be referred to three heads.

1. Those entirely External with respect to the whole of the Body, as the vibration of the Air which produces sound, &c.—

2. Certain Bodies ordinarily external or extraneous



# Sensations of Consciousness

extraneous to our bodies, but by various means, and ways introduced, and acting some way, or other on the internal parts; thus *Specacoantha* acts on the Stomach, but is still an external Impression.

3. May be such as are not ordinarily situated without the Body, but only arise in the body by a preternatural Accumulation or Generation, as is the case with Calculi: These may be considered in some degree as external.

We call those Internal when they arise from the Actions of the human body itself; when the Action of the Heart &c. gives an impulse or pressure on some parts of the Nervous System, as when the Temporal Artery is strong, a violent beating on the Auditory Nerve, or on the Bones gives the Sensation of Sound. - These we call Internal which are from the Action of the Body itself, but they are still external to the Nervous System, and therefore Sensations of Impression.

Sensations of Consciousness are motions of the Mind willing into Action. This may be a consequence more immediate or remote, of Sensations or Impressions. I do not say the Mind is conscious of all the Motions it does excite, but ~~conscious~~ only



# Sensations of Impression

only a part of them. The mind is conscious too of motions excited in the body by other causes than it's own willing. For instance, I am conscious that my arm is lifted up, though this be done by foreign force.

XII. We now go on to consider the Sensations of Impression. A minute consideration of these may be usefull and necessary; but in our present state of science it would be difficult, however we must attempt it as much as possible. As we can: not pretend to enumerate them all we shall only consider them under so many general heads, and this is allowable. The five senses are well understood without any definition.

XIII. The first are well distinguished as forming a particular class or genus of sensations. The eye be closed from access of light, pressure on the ball of the eye will cause a sense of colour. And the same of Hearing. The smell depends on bodies being in a state of vapor; hence these bodies which are naturally in a state of vapor affect the smell most, and so on in proportion to their volatility. Taste proceeds from bodies in solution, or from soluble bodies. Perhaps only bodies are sapid only in consequence of their containing



*Utile Halleri Linia Prima, § 556 & seq.*

\* Touch gives us a Sensation of Heat different from Light, & we can receive Sensations from Volatile Bodies different from those of Odor; in short we receive Sensations of Touch from every Body different from every other. (vide Prop. XIV part 2<sup>d</sup>.)



# Touch

containing saline particles.

2. Obvious.

3. The various Impressions of Sound, Colour, and Taste we give a general or abstract account of, and this is what I call a Genus. The Eye perceives Figure as well as Colour. But I think that Colour and Figure are only perceptions of circumstances of the same sensation, as inseparable as Tone and Intensity are circumstances of sound.

XIV. Touch. Accuracy of Discernment in this sense has been referred to this head by Philosophers, when they could not refer it to any of the other four. — With what propriety I am now to examine.

1. It is plain that we receive Sensations commonly referred to Touch from every body we can perceive <sup>those that act on the organs of the other Senses.</sup> to be different from ~~any other~~ therefore there is no common Quality to unite them.

2. For instance every part of the Nervous System that we can perceive is sensible to the effects of heat, so with respect to external Impulse, which may be made on any part of the Animal Economy where there are Nerves — Sometimes there are more or less sensible in proportion as there are thicker or thinner substances interposed between them & the acting body. The sensation of Touch then is not



\* I grasp a small Ball in my hand & judge of the spherical Figure, which is a Sensation of Impression; but if a Tube in a Parallelepipedon I cannot grasp it in my hand but examine it by removing my hand from one part to another which is a Sensation of Consciousness. I said that the first kind of Sensations, those of Touch, are those of the force of Bodies in moving each other, the Sense of the Percussion or pressure of Bodies on one another which is their Action. These are strictly the Sensations of Touch



not like the other four, connected with any particular Organization. Certain parts, as the Extremities of the Fingers are better adapted to feel the difference of roughness &c. of Bodies than the other parts of the Skin; but here the Sensation differs only in degree.

3. No Generical Affinity. Hence Impulse, Smarting, &c. are all referred to the head of Touch.

4. By Touch we acquire our notion of Solid Bodies, of the force and resistance of bodies in motion. Whilst certain Sensations of Touch are thus characterized, by giving notions for certain bulk, figure, &c.

5. There are too Sensations of Touch which arise from particular bodies, which do not give any Idea of the Nature of the body causing the Sensation, as Heat, Cold, Chemical Acrids, &c.

6. Nor from what Hunger, Thirst, &c. arise, which is only felt in a particular part.

7. This Philosophers have considered as referring to most of our Sensations. But some of them are to be referred to the sensations of <sup>Impression</sup> ~~Impression~~, others of Consciousness. — Thus, if I want to discover the length of a room, and do it merely by stretching out my Arm, the Sensation which arises is not of Impression, but of Consciousness. —

The



The sensations of Touch may be greatly varied, & therefore we come to the

**XV.** By Sight we perceive the motion or change of Bodies, or that one body at rest may be carried along by another Body in motion: But by Sight we would not acquire any Idea of the Solidity or Impenetrability of Bodies. It is by Touch alone we perceive the force or Momentum of Bodies in Motion. And it is thus from one Body's moving another we acquire our Ideas of Action.

Here we perceive the difference between Percussion and Pressure — These are referred to qualities in bodies we call mechanical.

**XVI.** Now when I say we get our notions which are inseparable from Body, from this alone — Let us enquire how we get our other senses.

We see a luminous body giving Figure to an opaque body, if ought be interposed betwixt the luminous body and the space we do not see it; In like manner if any thing be interposed betwixt our eyes and the opaque body, it is equally invisible. Hence we conclude that from luminous bodies there is a constant Immanation, reflected from ~~our~~ other Bodies and applied to our eyes &c.

This has a like Application to most of our other sensations



\* Now may we suppose that the increased Impetus of the Blood in sensible vessels acts in the same manner as external Impressions evidently act? I propose this as a Problem, the investigation of which must be referred till after. Is it a chemical Acrimony or can mechanical Impression be so varied as merely by the Force of Impulse to give the different modes of Sensation. I only inquire into the Fact.



Sensations, and are fundamental to them. We trace up our sensation of sound to vibrations in a solid body communicated to the air, and conveyed by impulse to the Auditory nerve. In Smell and Taste a certain solution takes place in order for their action, and all of them may be reduced to the sensations of Impulse, and these may arise in almost every part of the Nervous system.

**XVII.** All our other Sensations are only different Modes or Sensations of (Touch &) Impulse.

**XVIII.** In the heat the patient says the pain is sometimes like the point of a sword, striking into his foot; at other times he complains that it is like distention; other times like a ligature; other times like a dog gnawing.\*

**XIX.** Chemical Acrids cannot act but in a fluid form, and hence tho' they are applied in a dry form yet it is necessary for the body to furnish some substance to dissolve them previous to their action.

The velocity and quantity of matter moved determine the sensations of Mechanical Powers (XV) indicated by Impulse and Pressure.

Substances possessed of certain Chemical qualities can act on the Mixture of other bodies - and the effect of such Action is generally a change in the mixture or general Aggregation. — There



There are certain Bodies, distinguished by chemical Qualities applied to the nerves, produce particular Sensations. Thus if the Luteicle be removed, and Salt or Vinegar applied, a Sense of Smarting arises, with difficulty defined, but well known.

I have said that Chemical Acrids act by affecting the mixture or general Aggregation; but the Sense of their Impressions arises from affecting the medullary substance in which the sensation depends. — This Sensation is often different from the Sensations of Impulse.

All Sensations that are painful are referred to the part where they are felt, not to the substance producing it.

XX. Nothing acts more powerful nor is so universal as the Operation of Heat; at the same time this operation and the Sensation it produces are often very nearly the same as those by other chemical powers, and may arise from thence or from the other. This gives a supposition that Heat and Chemical Acid are the same. — This consideration will carry us farther — The Circumstances of heat does cause an effect upon Bodies without changing their general Aggregation, viz, by expanding them. At length it destroys the mixture in such a manner that they cannot



cannot be looked upon any longer as parts of the same Mass. — The Chemical powers act on Mixture, but do not always absolutely change it: they act on mixture too with respect to Aggregation. And as heat may act without changing the mixture, so may Chemical Acids in some degree.

The Chemical powers that I say act on the Medullary Substance do act on the mixture, tho' sometimes they may not go the length to absolutely change & destroy it. The Sedative Salt is insoluble in Water or Spirit of Wine as long as these are cold; but in a certain degree of heat dissolves freely in both. — The medullary substance having the properties of a living solid becomes liable to Sensation, only in consequence of a certain degree of heat to which it is applied, and in which it is kept. Now I would insinuate that it might be subject to a new Modification by heat & other Chemical powers that belong to its mixture, but at the same time short of altering or changing it. — And as in Sedative Salt we may find a difference in the Chemical qualities acting on the Animal Solids.

In Answer to the question at the end of Par. XIX. — There may be a distinction of Sensation in Smell, & Taste, and Heat (which are entirely Arbitrary and depend



Gauche Pathologia 292. 293. 8.



dependant on the will of the Creator) and which give no Indication of the nature of the substance acting, And the Chemical Acids give a sensation of puncture resembling a Sword - yet we cannot from hence infer that they resemble it in figure, so we have laid it down as proposition new, that the same sensation may arise from different causes. Pain is supposed to depend on a tendency to a solution to Continuity, and as this happens in Mechanical Qualities from a sharp Instrument, it has been supposed that the same takes place in Chemical Acids, whose ultimate particles have been supposed like a wedge. Mechanical Philosophers have considered the whole action of Chemical Bodies on each other, by means of their particles depending on size and figure.

If a particle of Y be united with a MS into a coherent Mass, L will separate them, but we do not suppose this is effected by means of the L acting like a wedge, according to the Corpuscular system; we account it for it by means of Attraction. This is different from the Impulse of bodies depending on Figure or the Mechanical properties. Hence Chemical Acids may not be sharp pointed bodies. The notion that the Particle of Chemical Acids being Angular



Angular &c has taken its rise from observing that the Saline which are the most acrid are in their more evident concretions Angular; but this is to be otherwise accounted for.

XXI. The Sensation of Smart from Chemical Acids is not distinguished from a painful degree of heat or even cold, and can produce the same effects as a Blow which leaves a sensation of the same kind.

XXII. A propensity (it will be here necessary to define what it is) is a desire to remove an uneasy or painful sensation; and a Desire, a tendency, (a propensity) to motion, which the will accompanies but does not govern or direct. For under a certain degree of uneasiness of sensation or Stimulus, the Motion is absolutely involuntary or cannot be resisted. This sometimes can, at other times cannot, be restrained. And tho' the will thus accompanies them, yet it cannot excite them without the presence of the Stimulus. Tho' the will gives a desire to the motion, the will does not it and the volition is no end or purpose but to remove the Stimulus, and not designed except in so far as Experience has taught us.

By these Characters I think they are distinguish:  
ed



ed <sup>from</sup> Voluntary, or those which are designed to an end; and distinguished from those motions which take place in our system, without design, to an end, and without our consciousness. Instances in Sneezing, Snorting, Laughing, Urine, Stool, &c.

The Propensities to Eating, Drinking, & Coition — half the human and (almost) all the animal propensities are of this kind; they are called Instinctive motions, and generally are founded on the sense of uneasiness or pain, which the will accompanies, but by no means directs.

These Propensities are of two kinds.

1. When directed to some external object, as Food, Coition, &c.

2. The other and much the larger are entirely confined to exciting motions in the body itself. All except laughing arise from painful or uneasy sensations. They are all united in general effects in producing propensity, and even on that account too deserve to be marked as a peculiar set of sensations. They arise from sensations of a very different kind, sometimes of Acrimony, sometimes merely of consciousness.

Sneezing is an instance of the first kind.

Yawning of the 2<sup>d</sup>, or consciousness — and Coughing



Coughing of both kinds - it arises from an uneasy tickling in the Trachea - sometimes from an Obstruction in the Lungs without such uneasiness, but merely from a difficult passage of the Blood.

I have marked that the Sensation is often very obscure, and we often are little attentive to the Sensation, but only to the propensity - This explains our difficulty for accounting for most of them - Hunger is hardly attended to as any Sensation, whatever, but as a Propensity - Some have referred it to Acrimony, and from our knowledge of certain Stimuli we may admit of it. After a certain time the food acquiring an Acrimony, the manner of which we are not the least conscious of, and perhaps it is referred to a Sensation of Consciousness, either to too great constriction or too great Vacuity, a certain feeling of debility. It is possible it is a Consciousness with regard to the general state of the System - we are often little sensible to the Sensation exciting it.

But I leave this in some uncertainty from its not being possible to reduce these propensities to one head of Sensations. Yet if we consider the peculiarities of the propensities, and the peculiarities of the Sensation, you will observe that several of these may be considered as distinct senses,  
and



## Sensations of Consciousness.

and hence some Physiologists have spoken of them, under the title of the sense of Thirst, Hunger, Lust, &c.

When we mark them as distinct Senses, we must take notice of their propensities. They may be connected with different Stimuli which act sometimes on different parts. Thus in the instance of Coughing it is indeed confined with regard to the parts acted upon, to the parts of Respiration, but these have a considerable extent - Irritations applied to the Bronchia, Trachia - The state of Circulation - Stimuli to the Diaphragm, are among the causes of Cough - Sympathetic Coughs too arise from Stimuli applied in very different parts of the System.

(We come now to the)

## Sensations of Consciousness.

XXIII. Perhaps I have done wrong in setting them on the same level with the Sensations of Impression, as they are not primary but reflecting a Sensation which necessarily accompanies or is super-added to Sensations of Impression.

But I must observe that I mean to give the term Sensation greater limits than usual, for I mean to apply it wherever there is a new origin  
of



of Motion, or an Interruption or diminution of Motion. Thus, the several passions of the mind stop or encrease the motions; every such stage I can mark as distinct I call a fresh sensation. I found it was extremely difficult to keep them separate from each other.

What is marked 2<sup>d</sup> in the Syllabus should stand first, and we shall treat of this 2<sup>d</sup>.

<sup>as to a Perception</sup>  
This Dr. Haller calls the *Anima Conscientia* &c. which is the most general, and accompanies all our other sensations. Mr. Locke speaks of it as the *Sense of Existence*. It is the fundamental proposition the *Cogito* of Des Cartes. It is this that founds out notions of existence. I have added of our Identity, but this is a matter of still greater Metaphysical Nicety, which we must enter into here.

1<sup>st</sup> This could not arise from an Impression, but from Consciousness. It might seem no more than a Consciousness of a weaker Impression - this is in the main true, but is the same as Blackness & Cold with respect to colour and heat, being no more than sensations which arise in consequence of the absence of Impression.

3. This is a mode of Apperception, but it is extremely difficult to mark the Circumstances or different modes of Apperception. We are sensible of the Dullness



dullness of our Sensations in different cases - we are very sensible of any change that happens in our usual train of thinking, and of our complex Ideas being more or less complete.

4. To be sure this and the last are parts of Apperception. The Stahlians have thought we will, when we don't know we will. No man is conscious of his willing the Actions of his heart, or any Inspiration or Inspiration - And when a man has been accustomed to any particular habit, as taking snuff &c, he often does it without thinking or even knowing it.

I have lately given examples of Propensities where we lose the Sensation entirely, and pay regard only to the Propensity; so many motions attend both with Volition and Sensation, but without our Consciousness of either, and the mind only acting, as in Dr Whittle's System of necessity - a certain part of the Body that operates fundamentally in producing motion.

5. (1.) This may in some measure be considered as a part of the general Apperception. We are sensible often of Inaction accompanied with no volition - Thus I will to bend the Arm; we are sensible of no motion of the Muscles, tho' attending the will - Nor do I select out any particular muscle



muscle, unless I know it by Anatomy &c. Here then is one set of motions we are not conscious of, only of willing the end and purpose.

(2.) In most of these External Actions there is a complication of a variety of motions: we commonly attend only to the end in view, and we direct them all to and are conscious of the several particular actions of which this general Action is the result.

I will here employ the Simile I formerly made use of, viz, throwing a Stone — I here perform 50 different motions which any person will perceive they have not attended to.

(3.) Tho' on ordinary occasions we are not conscious of many external motions; yet by Attention we can be conscious of every external motion under the direction of our will.

(4.) Nor commonly can we become conscious of all the particular motions that enter into a complex one, but with regard to many we have lost knowledge of by habit, yet if they become universally violent we immediately are sensible of them, as in Respiration, &c. If a Tumor be in the Abdomen we become sensible of the force we employ to depress the



the Diaphragm, and so of the other Phenomena attending it.

(5). Motions the most involuntary we become conscious of when weaker, or peculiarly interrupted: Thus if a Muscle be spasmodically contracted we immediately become sensible of it - The heart we consider as not liable to the will [except by the Stahlian] - yet we become sensible of it in Palpitations, and in sometimes of its Intermision in Syncope proceeding from an affection of the Mind. By this then we perceive that there is a Consciousness of Motion in many parts of the body not commonly attended to.

We should distinguish which are Sensations of Consciousness, & which of Impression.

By Touch it is said we acquire our Ideas of the Impulse of Bodies in motion: This partly arises from Impression, but as much or chiefly by the Consciousness of the part of our Body moved. - We acquire our Ideas of Consciousness more certainly from our own efforts in moving bodies.

Mechanical Impressions should be distinguished from chemical, the first being connected with motion, the second seldom or ever.

C. (1) we are particularly conscious of the State  
of



of the Animal powers, their vigour or debility, and hence we have a notion of the whole System with regard to every part; but

(2). We are conscious of force exerted on every particular Action: this is not of the Absolute or Real force exerted, but comparative with respect to the other parts. Thus  $\frac{1}{2}$  gives as strong a Sensation <sup>to an Infant,</sup> as 20 or 30 to an adult. An Effort which would be uneasy to a sick person would hardly be perceptible to one in health, and thus it is that we judge of resistance and weight - but the Sensation equally arises from debility and from external resistance: Thus, if a Paralytic affection attacks my Leg, I feel the same Sensation on moving it that I should do if a weight was tied to it, now I am in perfect health.

Sensations of Interruption and Resistance equally arise from our own debility, as from any other cause - This is a fruitful source of disorders in our Pathology: Thus when in health we perceive no weight from the head, but in a disease of the Muscles of the Neck we feel a weight from it. We do the same with regard to the Internal Muscles of the Eye, which in looking at common objects do not give us any uneasiness, but when inspecting very small or very near objects we



we then find a sense of pain.

We have a Consciousness of the State of the Action of the heart in a Polypous case, not to be distinguished from that in Syncope purely from a defect of the Organs of Sense.

The Stomach too is a fruitful source of disorders in our Pathology, when so many Symptoms arise in this, which are so different in their causes. — We are yet uncertain whether the Sensation of Hunger is External or Internal, whether from the Sensation of Impression or Consciousness: Thus Nausea arises from Ipecacoanha, but the same Sensation can arise too from Repletion, or even from a Sense of Consciousness. —

With regard to many powers affecting it we are uncertain — thus a retreating Gout will produce this Symptom: Some Physicians have imagined that the Gouty matter is transferred here from the Extremities, and acts <sup>as</sup> an external Impression — but a Luxation of the Ankle will induce this; here we cannot suppose a translation of matter. In like manner when I find a sense of weight at Stomach, this may be from a quantity of matter accumulated there; and it may arise too from a sense of debility, or from a Sensation of Consciousness of the Stomach not acting to evacuate its contents,

by



by some defect of the Pylorus - A small quantity of food may in this case occasion this sensation even tho' it be not of an indigestible kind -

An inverted motion too of the Stomach may occasion this sensation of Consciousness.

The like sensation may undoubtedly arise from other Internal parts, particularly the Intestines. When a man feels an uneasiness in his whole system from a small quantity of wind pent up there - when this wind is evacuated a certain sensation of evacuation with respect to the whole system takes place; this is undoubtedly a sensation of Consciousness.

We might go to the Uterus & the genitals of either sex for instances of a sensation in particular parts, giving a sensation of Consciousness to the whole system. Changes too may arise from the state of the Internal parts, tho' we have no Consciousness of them.

From what has been said we deduce the following Corollary - That in increasing the various sensations of Consciousness they are particularly connected with voluntary motions; that they are connected, tho' in a lesser degree, with the motions of the heart; less in the Stomach; and still less in the Intestines, and hence they pass to the most  
obscure



obscure kind, to motions that give none at all unless in unusual states. And in this last case the usual effects that attend consciousness do ensue.

In many parts of the System to which consciousness does never extend, Debility may produce the like effects. Hemorrhages depend always on some inequality of the distribution of blood in the System, so that a greater quantity may be thrown upon one part than another; and as in the Heart a Congestion may give occasion to an increased Action of the Heart & Arteries, so this particular Congestion may cause an increased action of the Arteries of the part, from whence Hemorrhage will ensue.

**XXV.** The first part of this is obvious, that to any effort a certain force is necessary; but I observed it with a view to start a question, if force be alone referable to Sensation, and if size be not also necessary?

Objects below a certain size produce no Impression. — Certain Minute Philosophers (Porterfield & Cooke) have thought that there is a connection between the Minimum visibile and the smallest fibres of the Optic nerve, but I do not see any — a certain size of Image, a certain reflection of rays



rays is necessary to give the sensation of colour on the Retina. In chemical Impression a certain <sup>centra</sup> ~~con~~centration is necessary. — We have conceived that in chemistry it went per minima, the smallest particles of Bodies on each other, but a certain number of these is necessary.

This force must be limited on the other hand, for in a certain degree of force it does destroy the Organ, whether this be from external force or chemical Acids.

1. A certain force of Impression, independant of Præputure, destroys every Sensation whatever but a painful one: — Thus, a strong (sensation of) Light destroys every other Sensation but that of a painful one; and if a polished surface be composed of various colours & this exposed to the Sun in such a manner as to have the Rays reflected on the Retina, all distinction of colour is lost, and nothing preserved but the Sensation of Light — So of Sound and Taste — It also extends to some impressions of Touch.

It is to be observed that this Stupor is not confined to the Sentient Extremities; but if it can be communicated to the brain it gives more evident signs of the effects of these Impressions — Thus a strong



strong sound takes off all sensation but that of Stupor— And a strong blow, merely by its vibrations communicated to the Brain occasions the same. Few others can be so strongly conveyed there, but there is one, Electricity (or Lightning) which acts there & in great degrees, it is uncertain whether it destroys the Organ altogether, or occasions Stupor in a high degree.

**XXVI.** It appears that distinct and actual Sensation is limited to certain bounds— Different sensations do often arise from different degrees of Impression, but these are not exactly proportioned. They appear strong or weak in so far as they increase or diminish the present state of the system: Thus the light of a candle will have as strong an Impression on the Organs of vision when I come entirely out of the dark, as the sun when I look at it in the daytime: Hence sensations are merely relative. Heat and Cold are the most remarkable instances of this, for if I take 3 parcels of water of 50, 60, and 70 degrees, & immerse one hand into 50 & the other into 70, on taking them out and plunging them into the 60 the same water will appear warm to the one hand and Cold to the other.

Suppose



Suppose the Scale of our Sensations to be divided into 36 Links; a person whose Sensibility begins at 1 will end at 36; but another whose does not begin till we come to 12 will run on to 48. It has been imagined that after Sensation is once begun, it would go on in equal progression in all persons, that is as I answered to 12, so 10 would to 22, and so on, but I am inclined to think that a person whose Sensibility begins at 1 will scarcely run on to 36, whilst another who begins at 12 will go beyond 48, i.e. making larger links or degrees, or requiring a greater force to the several Sensations.

**XXVII.** Most of our Sensations may be derived from Impression; but our Sensation gives us no apprehension of the Nature of this Impression. Thus Red and Blue give us the Ideas of distinct colours, but they are the same colour only differing in degree. We had no Idea of this before Sir Isaac Newton's Invention of the Prism.

In Sound we had always a Notion of gradation, but in no other Sensation.

With respect to odorous bodies; we have no Idea of the comparative excellence of the Rose or Violet from our different Sensibility. There is



is no Scale for Odour and Taste, so that we do not know whether Sweet and Bitter, Sated and           , are different degrees of the same Impression, or different and distinct ones.

XXVIII. Here I must again refer you back to Heat and Cold. From the same degree of Force (or heat) we have two different Impressions. Heat: withstanding the negative nature of Cold, it is sometimes active with respect to the Nervous System. Its effects on the living body are not merely the lessening the effects of Heat. Heat is always the principal Stimulus in our System, hence Cold should lessen the effects of this Stimulus in proportion to its actual force; but in the case of the different degrees of water just now instanced I have shewn that this doth not happen; hence Cold with respect to the Animated System is an actual power - and one and the same degree may be more or less a Stimulus in proportion to the previous state of the System.

Here Cold, in consequence of Sensation proves a Stimulus - contrary to the Materialists.

The motions of our System are not always in consequence of Sensation - Ours is a material System in so far as it follows in most cases the laws of matter which take place in other parts of  
of



of Nature - Hence (Cold & Heat act in certain degrees, as on inanimate bodies, destroying Sensation entirely.

Whoever would consider the effects of heat and cold must consider the absolute force and modification they receive from Sensation, which we shall consider hereafter.

XXIX. We know this from the inconstant Nature of Impressions, their mixture, which very quickly succeed each other.

XXX. When we look at any Object and then turn away the head, we see the Figure for some time.

Considering the notions that have been in the School of Physic for sometime past, "That the Nerves are hollow Tubes, with a liquor which must be Elastic and capable of Oscillation, otherwise the Sensation could not remain. —

XXXI. You may consider this at full length in the Metaphysical Writers. But if we really find that two Impressions be made at the same time as Colour and Sound, it is only by passing from one to the other that we perceive both. —

Some Motions may be excited without the concurrence of the Will, by the power of Stimulus alone. —

The



The Musician knows the Union of Sounds forms Harmony; &  
the Physician & Cook know the effects of the combination of  
Odours & Tastes.



The different force of Impressions must be here noticed - A strong one will be received in preference to a weak one; as, after viewing any objects from a window, I turn around to these in the room, when those present obliterate the former Impressions.

Here the Aphorism of Hippocrates is brought in, That if two painful Impressions be made at the same time, the greater entirely obliterates the lesser, or we are entirely insensible of it.

XXXII. When certain Impressions are so lasting as to cut out every other, this is called Attention.  
Par. XXXIX. Is necessary in order to give this it's full effect.

XXXIII. This is a dispute which has been warmly agitated, and if allowed will destroy the materialists altogether. - I am for the Liberty of the mind, but not so far as entirely to reject the operations of matter.

XXXIV. The Painter and Dyer know the Effects of several distinct powers in producing a single one - ~~as the Chymists and Cooks.~~ Here several curious speculations arise. - The formation of these mixt effects may be explained. Thus Sour and Sweet produce a Taste different from



from either of these separate; it may be then a Query, whether there are two separate Tastes, or only one from a Chemical mixture? In several instances of Chemical Impression there is room for this Supposition, as they produce but one Sensation - or if two be produced, only one will be felt and the other neglected. - Odour & Taste are perhaps in most cases combined together, especially in Chemical Impressions. - The Acid Taste and pungent Smell are certainly Chemical Impressions.

The Tongue is sensible to Chemical and also to Mechanical Impressions. How far these may be united to give a mixt Sensation deserves to be enquired into.

Some Sensations may be more intimately mixt than others, as in Colour, Green is more uniform and gives less Ideas of a mixt colour than Purple; And Bitter and Sweet remain (in Taste) inseparably distinct. The more intimate the mixture, the more agreeable, as in Music, the more union in the vibrations the compleater the Harmony. - Bitter and Sweet joined are more disagreeable than bitter itself, in the same manner as two Sounds that are discordant are more ungratofue than each separate.



XXXV. The neutrality must mark the Union of the several Ingredients.

XXXVI. As the motion of a fiery coal in a circle, or of a board with different Colours.

XXXVII.

XXXVIII. It is well known in Physic that if I just now give a certain dose of an Emetic, as gr<sup>ss</sup> of Ipecacoanha, that we shall be obliged to encrease the dose if we go on repeatedly - The same with Opiates &c. - The same takes place in the Ear with regard to Sounds - This though a general is not an universal rule: For on the other hand where the chief effect is to action, we find these repeated become more easy, acquiring a weaker Stimulus - This may happen in Emetics. It is difficult to determine when the one and when the other Law will take place. It will depend in great part on the frequency of Repetition: If it be repeated once a month the same dose will do;  
if



if every 3<sup>d</sup> day a larger dose will be necessary  
-if more frequent still a less will be suffi-  
cient.

XXXIX. Thus, after having been some time  
in the dark I see as well by the light of a  
Taper as I do by that of the Sun in the day  
times.

1. In no part of the Body is this Medullary  
substance exposed to the action of external bodies.

The Extremities of the Nerves in the Cutis are  
covered with the Cuticle - In the Mouth, Fauces,  
and Alimentary Canal with what is analagous  
to it - There are besides but few surfaces but  
what are defended by an Exudation on the  
skin by the sebaceous matter &c. which are  
interposed between the action of bodies, and the  
Medullary substance.

On taking away this Mucous substance, the  
membranes (now naked) become more sen-  
sible, and hence we may account for extreme  
Sensibility in some parts.

2. I have already told you Mr De Bourdeau's  
Opinion with respect to the unchangeable  
nature of the Medullary Fibres - I said too  
that this in itself may be doubtful, tho' in  
size



since the same, yet they may be different with respect to general Aggregation, as more flaccid and soft at one time than another, but I would not advance this as a change of the medullary Fibres (or Substance) - for there is at all times a fluid betwixt the Nervous fibres and their membranes, and this change may happen from a different proportion of fluid with which the fibres are separated. But sometimes there are changes where it would appear the whole is converted into a Homogeneous Fluid, in which case the fibre itself must be affected. In the semi fluid gelatinous state of the Latus in its Embryo state there is not that firmness that there is in an after life, and we see the difference in sensibility manifestly connected with this change, as it runs thro' life we must impute the same difference to Sex and Temperament, & that on whatever sort of motions or circumstances the sensation depends, we may suppose the medullary Substance more or less fitted for these motions in itself. The medullary Substance itself must be less liable to change than other parts, and there is the strongest reason to believe that it is the fundamental parts of the Animal System



System &c, as has been observed before. Hence the Constitution in after life may depend on the original Stamina of which it is composed. This, then gives the greatest difference with respect to Sensibility, the others are merely local and Temporary.

3. We can observe, in Inflammations of the Eye, the Sensibility vastly increased - In common when we shut the eye we exclude light - but a person with an Internal Inflammation cannot bear the light even with the addition of several cloths over his eye lids - some have this faculty extended so far as to see in the dark; and some have possessed this even without Inflammation.

In Inflammation the Impetus of Blood is increased and these vessels extended, so that every portion of cellular substance connected with these vessels must suffer a proportionable Tension, hence the Extremities must be extended, or be under a state of Tension. Physiologists have endeavoured to destroy this altogether - But if it be proved afterwards that the Nerves have Oscillations, - something Analagous to Tension is necessary, & tho' this be somewhat different from the State of Tension which exists in these substances we are



we are commonly acquainted with, yet even in these Tension makes them more capable of Oscillations, as we see in the Glottis, an instance taken from the human Body. — Nature has been capable of providing for such a Tension — in the optic nerve, where the Artery is ramified with it in such a manner as that it must always be in some degree of Tension, as we observed before that this Sensibility is increased when it is subjected to greater Tension, as in the Inflammation of the Eye.

In the Membrane of the Nose what an unusual number of Blood vessels are poured out

In the Tongue an Artery is traced into each Papilla more evidently than the nerve. — (I cannot here help marking an observation of Dr. Monro's, which I think serves to confirm Dr. Cullen's Notion of Tension; that in the Tongue on applying a sapid body [especially towards the upper part] the Papilla are evidently erect: &c.) —

When we see this provision we cannot doubt but Nature meant Tension, and in Inflammation the increased Tension produces an increase of Sensibility.

En



In some external surfaces I have seen from a want of Circulation in a due degree (or a want of a due Tension) a loss of Sensation induced.

A. Heat is the vivifying Spirit in Animals—whatever the State of Sensibility be, yet it is brought into the vital state that we perceive in living Animals chiefly by the Action of heat, and we find it is strongly connected with it. As Sensibility in any degree is principally to be attributed to heat, in different degrees of that heat the Sensibility may be in proportion.—Want of heat, abstracted from Sensation, is always the means of destroying life in the part or whole System. Does this Heat operate by encreasing the Elasticity of the nervous fluid or of the Blood? This is a question we are not as yet ready to enter upon.

Though we may suppose there is a considerable difference in Sensibility according to the difference of Temperature of the nerves or whole System, yet whilst heat is encreasing to 62° or the heat of our bodies, we do not find in that progress a manifest encrease of Sensibility in proportion to additional degrees of heat applied.—We have a power in the System of



of generating heat, which goes with the other, but after a certain height its generating power does not correspond with the external temperature. Sensibility as combined with different degrees of Heat has not as yet been attended to by any proper observation.

5. I have said in what manner our Sensibility is increased by the present state of our nervous system - If we are used to weak Impressions we are hurt by strong ones - If to strong ones we are imperceptible of weak ones.

6. This subject has hitherto been considered as relative to the sentient extremities alone - but regard must always be had to the Nerves themselves; as, if they are compressed, the sensation is instantly lost. - In different degrees of Compression a more or less vivid Sensation arises.

7. The Nerves being in a proper condition & perfectly free, the Motion may be different as the Sensorium is in different states. - It must be free from Compression &c.

It is not the Brain's being free from or exposed to Compression that determines the Sensibility: - Thus Opium and its effects cannot be reduced to Pressure - Between Sleeping and waking there are



are different states of the Sensorium, on which the different degrees of Sensibility depend. — The most common opinion is that there is a fluid secreted in the Brain, and distributed to every nerve for sensation as well as for motion. This may be the fluid affected. When I mentioned Tension as affecting the sentient extremities, the fluid of the Sensorium must be given.

With regard to the Sensibility of the Sensorium, a curious enough Speculation may arise. — It often takes several Tones, if I may be allowed the Expression. — There is, for instance, one State or Tone, from whence a Sense of Alacrity in its Functions arise, hence Springs Courage and the like passions. — In this State it is more sensible of gay, and less sensible to sad Impressions, and abstracts from any thing different from the Tone the Brain is at present affected with. —

The same with Fear, Timidity, &c. at this time are insensible to all the enlivening Impressions, &c.

8. This Attention depends especially on the state of sensation. — This State may be resolved into the State of the Sensorium, which is the cause



cause of different States of the Sense in the Body at different times.

**XL.** So that if we could say that any part was endued with Nerves, we would conclude a priori that it was sensible.

I think that whatever has a fibrous Appearance is a continuation of the Original Stamina, or a part of the Nervous System.

In Tendons where the cellular Texture is become dense, the Nerves are so compressed as to lose their Sensibility—Perhaps after they have lost their Sensibility in this way they may have it restored by Inflammation or Tension.

The Body is only sensible in consequence of Nerves distributed to it's several parts, hence as I observed before, where we can discover Sensibility, we can infer a presence of Nerves.

There have been different Ideas of Nerves in this view— we have considered them as wrapt up in certain insensible Membranes— but some of the French Physiologists have taken it into their heads to consider the Membranes as the Organs of Sense.

We consider the medullary Substance as the Organ of Sense; because whenever this is deprived



deprived of its Membranes (as in the Retina) it is sensible.

Again, the Membranes may be examined by themselves, and then we find them totally insensible. Dr. Haller has found in every part of the body where we can examine, their extremities (or these we call sentient) that it is divested of these very Membranes in which the French Physiologists have supposed the Sensibility to be seated.

From the same substance being at the beginning and at the extremities of the Nerves, we conclude the medullary substance communicates.

As Anatomists have not been able always to trace the Nerves, we are obliged to return to Experiment. Dr. Haller has done much in this way, but they have not been universally satisfactory—some even denying them. It has in a manner been put to the Number of votes.—I would not trust too far to the Experiments, as these are fallacious, nor to what an extent they go, nor how far they are rejected. Matters of fact are, it is true, very inflexible, but it is very difficult to establish it.—The force of negative Experiments have not yet been ascertained.— One direct one is



is much stronger than a hundred negative ones; but still many negatives will shake a positive one.

The greater Sensation does not always take off the lesser; but some timid Animals will not emit a cry even on touching the most sensible part.

If some people have asserted that they found a membrane sensible, which Dr. Haller denies Sensation to, he says they accidentally touched a Nerve, but that the whole Membrane is not sensible.

The Pleura has been much the subject of controversy. Dr. Haller supposes some passing Nerves are affected by the Inflammation. I add that parts which are not sensible in their ordinary state become so by Inflammation or Tension.

We lose our consciousness with regard to Impressions we are long and much used to. I do not feel the Pulsation of Arteries in common, but in the Tooth Ach I feel every stroke most distinctly.

Experiments with Chemical Acids may be fallacious, because they give a kind of motion to substances perfectly inanimate, viz, by crusting them up, hence particularly so with respect to living substances.

After



After the Muscular Fibres are contracted to a certain degree, they cannot be farther contracted by any Stimulus whatever, as in the muscles. — Dr Haller proves it with respect to the Vesica Uri: — no — And hence it is probable the same takes place with respect to the Arteries, which he says are insensible because no contraction took place on the Application of certain Acids.

**XLI.** The immediate cause of Sensation cannot be explained, because it depends on the Mind, of which we know too little to form any conclusive Determination. That certain colour by candlelight shall appear blue and by day light green, shows that our Organs are connected with a certain set of Circumstances which we call Remote Causes. — I propose here to explain what gives the peculiarity of Organ.

1. Suppose the Auditory Nerve and the Retina to be professedly of the same Nature, yet as they are not exposed to the same kind of Impressions, a difference may from hence arise.

2. We can see this in the Eye, and Ear, where where the Apparatus is such as collects the Light in greater force. — The Auditory Nerve is so spread out that a weak impression of sound is perceived here which could have no effect on any other part



part of the Body. The same of the Optic. Nerve: If I, by a glass, (which I can do) throw an Object in its full Concentration on my hand in the same manner as it falls on the Retina, no similar effect is produced.

3. We cannot distinguish the different degrees of Fineness in the Extremities of the Nerves - But in the Eye the Light comes more immediately in contact with the Nerve than in any other part of the Body - The Auditory. Nerve is so spread out as to vibrate with all the different Sensibilities of Sound. We may presume from the Impressions that the force must be fitted to act on the different Extremities of the Nerves in proportion to their Tension.

A. This you will understand from what has been said before - If I am in the dark I am sensible to any increase of Light - If in the Light to any diminution of it, or to any new degrees of darkness - The Body is sensible to wetness only in consequence of having been always dry. - The Fauces being always moist should be sensible to dryness however produced, and hence the Sensation connected with appetite of Thirst. They are sensible to drying powers from within as well as without, and every approach to the diminution of moisture - Every Evacuation increases Thirst: I knew a Nurse, who, the moment  
the



the Child began to suck, in that moment had a Sensation of Thirst excited in the Fauces.

5. This is a chief Article, for which indeed all the rest were added. Mechanical and Chemical Impressions are all of such a Nature that they may be made on any part of the Nervous System. The Sensation is the same, not varying in its kind unless from the greater or less Sensibility of the parts to which it is applied. Chemical Acrimony when applied to the Cuticle will often have little effect; but when applied to the Nerves, not covered with Cuticle, have very strong ones - (this indeed has effects applied to particular parts, independant of Sensation) - It arises partly from their being Muscular fibres, in this case the Contraction is excited. The same of Secretory vessels, particularly also those of a Gland. The Action of the Muscles in this case depends partly upon the Acid matter being applied to the Contractile fibre, but there is also a connection between the Contractile fibre and the sensible Membrane connected with it. If a Stimulus be applied to the Skin of my Leg and it be painful, it immediately excites the contraction of the Subjacent Muscles, and not only of those, but commonly of the whole Limb, and especially such as draw away the



throwing the Limb from the painful Stimulus, or in other cases to shake off the Body. Such is the Nature of all our propensities.

With sensations arising from particular parts are to be taken in such as arise from the whole System; some are excited from general effects of the Animal Economy. This may be of a common Nature and not such as in (3) - This is often merely an uneasiness, and we often perceive nothing farther than a sense of the propensity. - The Connection between the part acted on and the part affected depends on what Proximate Cause we know not. We can often observe that Stimuli applied to a particular part has effects not from any specific quality, nor from a relation between the Stimulus and part acted upon, but from the Connection between this and the other parts of the System. In the Genitals we perceive a particular Courage, Alacrity &c produced at the time. - Also from the Stomach, a glass of Wine produces Alacrity, Cheerfulness &c. There is here no peculiar Stimulus as related to the Nerves of the Stomach, but that the Nerves of this part are so united with other Nerves of the System, perhaps this extends to much greater length than has been imagined.

With respect to Specific Stimuli. In cases of Sensation in (3) the 5 Senses Seeing, Hearing, Smelling, Tasting



Tasting, there is reason to believe that there is a peculiar Stimulus both with respect to the Nerve and the (Stimulus or) Impression. This has been applied to many Medicines: Thus  $\Phi$  has an effect principally on the Salivary Glands, hence it has been supposed that there is a peculiar Stimulus in it for these Glands and these alone. I adopt the same way, but it will be here properly referred to peculiarity of Organ.  $\Phi$  may be referred to the (1) because the Salivary Glands are more exposed to the Action of it than any other.  $\Phi$  will act on the Stomach to produce Vomiting, on the Kidnies to secrete Urine; but it has a different relation to different portions of our fluids, and has an elective Attraction to such fluids as pass by the Salivary Glands and probably this is the whole of the specific Stimuli. In the same way Cantharides have been supposed to Stimulate the Urinary passages by a specific quality; but when applied to the Skin they Stimulate it also, and when taken into the Body, the Urinary passages, because they contain a Saline Matter which being dissolved more readily, passes off by Urine, and hence these passages are principally exposed to it.

Emetics and Purges belong to two Heads, as more or less diffusible or soluble in the Stomach—

If Emetics are more volatile and more diffusible they



they will be more readily applied to the Stomach and produce Effects there. In the Intestines purges act because more slow in dissolving, and it is, hence sometime before a large quantity of the Intestine can be affected at the same time - And it is from this principle that Purgatives in larger doses will prove Emetics, and Emetic in small doses prove purgative.

**XLII.** With regard to Vision, Perspective, &c. there is room for distinctions curious enough, but as I do not enter upon particular Senses I pass them over and come to general ones.

(With regard to external bodies at a distance) - It has been doubted whether we have any innate Judgement with respect to external bodies, but that we acquire it merely by Experience. But for my own part I think there are some external Proclivities which appear so from the beginning. - Thus a Child is fond of Light and has an inclination to touch it; the Child puts forth it's hand for this purpose towards the place where the Light is. It never puts it to it's Eye where it is perceived, but to a distance, and when this Light proceeds from a Candle, always to the Top never to the bottom.

With



With regard to the place of the Body feeling, there are 4 different cases.

1. Is the case of Impression made on the external surface of the Body or Limb - for the most part we refer the Sensation to the part where it is made.

2. Where we do not refer the Sensation with the same accuracy. This explains our Internal Sensations - here it is never with precision - a pain is felt in the Hypochondres, which may be seated in the Stomach, in the Colon &c., and we are often on dissection surprised to think how much we have mistaken the seat of the disorder. - In the Lungs we often think the disorder is in the external part of the Breast, in deep seated disorders of the Brain we often apply it to the external parts of the head. In both these cases we refer to the place whence the Sensation is made, as nearly as we can.

3. When we refer it not to the place of Impression but to another place often at a distance from it. Thus the sensation of a certain shrill sound is only found disagreeable in the Teeth. - There is another where the Application is made to the Meatus Auditorius, but it is felt in the Glottis exciting Cough, by communication



munication to a place of more exquisite sensibility. The same happens with respect to a pain excited in the Bladder, which is commonly only felt at the Orifice of the Urethra - Also the Seat of Rheumatism if we were to judge from the pain is confined to the Joints - but we should judge better if we were to say that the whole Membrane of the Muscle is affected, but the tightness of the Joints &c make it particularly felt there. Pains being found round the Navel in an affection of the Intestines gives no reason to think the parts under it are particularly affected, but felt particularly there on account of its Tendinous nature.

I know a child that had a pain of it's knee, which afterwards was found to proceed entirely from an affection of the Hip Joint.

Headachs are commonly referred to external parts of the head, and we are not certain but they are there till we try by Compression, and sometimes it is thus connected with an affection of the internal parts; but most frequently we find upon dissection that the affection is internal. Many of these external Headachs then do depend on an internal cause, because they are accompanied with deafness, dimness of sight, &c. Besides these affections



affections of the Nerves, we find motion internally produced very soon communicated to the External parts, as in the gushing of Tears &c. Hence in Internal Impressions I think there is a Communication by Continuity of Membrane. This is a kind of Contradiction to what was advanced before concerning the Nerves, viz, that they had no communication but <sup>by</sup> means of the Brain; this is true with respect to common Motions, but in violent and preternatural ones, it is by means of Continuity of Membrane also.

A. This is the noted one in Amputations where the patient refers some sensation to the Amputated part. We do not refer the Impression to the part where it is made, and it is hence probable that this arises from an Impression made in the Extremities of the cut place; for in ordinary cases of sensation the Impression is made on the distant Extremity of the Nerve, and communicated thence to the Brain. It is likewise certain that we are seldom conscious of the motion along the Nerve till it's arriving at the brain. As we are not conscious of motion along the Nerve, but upon finding an Impression upon the Brain refer it

to



to the part where the Impression is made, I conclude from the force of habit, we come to overlook the Acrid matter (or whatever gives the Sensation in the Stems) and refer it to the usual Extremities of the Nerve.

5. Many Sensations of Consciousness arise from particular States of the Body affecting the whole, and these we neither refer to any particular part nor to an external agent. As Debility, Alacrity &c. When it affects only a member we make a reference, but even this not always as we are not in common conscious of the motion of a particular Muscle but of the whole limb, hence the reference to particular parts is with little Accuracy. When we have a difficult breathing we are uncertain whether it proceeds from Internal Impression, or from something strengthening the Thorax externally, and as I said before we do not refer to the place with the same exactness we do to external parts.

**XLIII.** This might admit of a very large Comment, but we shall give it a very short one as it is so fully handled in the Books of Metaphysics &c. but among these there is some difference of Opinion.

Complex Ideas are formed I do not say how —  
whether



whether notions of personal Identity be formed originally I shall not now consider - It is sufficient for our purpose that they are formed at all. - Our notions of Identity are not entirely a Sense of Consciousness. If one was from disease to have his Memory obliterated I do not think he would have any Ideas of his previous existence - Or if all but one, as Hearing, be lost, we should also lose the notions of our identity. - This is in common to several operations of the human body. - I shall give an instance. - A person received a Contusion of the head, and was in consequence of it deprived of all Sense for some time, except that of Hearing, by which means he heard and understood people talking, but did not apprehend that it was about him, till his former Senses returned, and they were united to form a complex Idea.

The relation we have connected with our former Ideas more frequently proceed from our Eye than the Ear, but they are most commonly united. -

This case has often occurred to me in Hysterical patients, who are sensible of having seen persons and heard some words, but did not know that they referred to them, nor had any notions, at the time, of their own Identity.



**XLIV.** This, like the other, would admit of a large comment, but I refer you to the metaphysical writers - I shall only keep the general fact in view - The numbers of these heads are not pointed out by metaphysicians - I mean to hint them only - Means and Ends should be considered as a subdivision of Cause and Effect.

**XLV.** I have here to avoid dispute said most, but I believe all might have been substituted - all the conscious actions of men are founded upon pleasure or pain that are formed on volition, which is the consequence of the reflex Ideas of pleasure or pain, agreeable and disagreeable. - Sensation has a considerable influence on parts to which volition does not extend, as for instance, the Heart.

**XLVI.** Our first care in the pursuit of Science should be to take distinct Ideas, and not to include a number of particulars under one head - In doing this we often overlook several particulars which deserve to be distinguished from these Terms which are taken from a particular <sup>of a</sup> different nature. - Thus a pain is a Sensation strictly of a particular kind, but we refer it to too many sensations that are neither to be referred to any external object nor to any part of our body - This Caution arises from what I observe in Dr. Haller, 5 Vol. - 574.



A Fetid Smell, we call painfull, but this is certainly to be distinguished from painfull Ideas commonly arising from Stimuli applied to our Body — Haller has endeavoured to mention this in his *Primo Linio*.

Gaubius has divided the disagreeable into Dolor & Anxietas.

I have made an Attempt to the purpose of division — Of the disagreeable ones we have the most considerable distinction. In the painfull we constantly refer the Sensation to some part of our own Bodies, we never refer it to any thing external, nay we refer it generally to the large portion of our Bodies, very often limited to a small space. — Hence we distinguish this Sensation from that which arises from external Objects, and are constantly referred to them, as disagreeableness of Figure, harshness of Sound, and fetidness of Smell, with the like Impressions. — Here we commonly apply the term disagreeable when we apply it more strictly uneasy, tho' the pain be referred to the body itself, yet it is very commonly owing to Impression. — Disagreeableness is constantly owing to Impression.

The 1<sup>st</sup> distinction of uneasy Sensations is, that  
well



which belongs to sensations of Consciousness, which is a concurrence of Actions or motions going on in the Body itself, hardly, if ever, referred to externals or to the body, but purely mental. The different States of Accession arise from the mind itself, but are distinguished from pain by the place.

The various difficulties of Respiration and Evacuation of Blood from the Heart, we refer to some where about the Thorax, but with no accuracy, and they belong often only to sensations of Consciousness. I would fix the term, uneasy, if it were possible, but for this purpose a deal of Experience is necessary and so far as we can distinguish the sensations *quas volumus*.

On the other hand, if what I have just now said be well founded, there must be a like distinction of these *quas volumus*; but common Language has not gone far enough to establish a proper Language for it.

Pleasure is opposite to Pain, and may be such sensations as we refer especially to a certain part of the Body, as in the Glans Penis, the Sides, &c. and can be distinguished from most external Bodies that produce them, in the same manner as pain, tho' not so accurately. — The Pleasure of Venery is certainly distinguishable from the Agreeable  
C: nefs



Laubii Pathologia, § 683. to 691.



: nefs of Figure - and the like.

With regard then to certain Sensations from Touch and Light, we can exactly enough distinguish them, but with regard to the other Senses the agreeable is partly referred to our own bodies, and partly to the Body acting, as in the case of Harmony - They produce Sensations of Consciousness in the mind; this is remarkable in Belours and still more so in Taste, which is unsteady, whether we refer the pleasure to the Organ or to the Object producing it. —

The Sensations of Alacrity, Vigor, and the like are not referred to externals, as is the case with the disagreeable ones.

I would wish now to make some steps towards the Investigation of their causes. This is an ample and a difficult subject. We are chiefly concerned with the causes of the Sensations *Molestæ* or *Morbi*. These may be referred with propriety to two heads of Pain and Uneasiness.

**XLVII.** The disagreeable ones may be referred to 3 kinds.

1. From indistinct Sensation.
2. From Debility.
3. From the State of Volition; from the different modes of Aversion. —

These



Gaub: §. 682.

XVII

XVII



These may depend on the State of the Sensorium alone, or on a new evident & considerable disposition of other parts of the Body.

Sometimes from Fear.

But Sensations of Consciousness do not always produce Fear, as in the Asthmatic Fits, where the patient having experienced that they will end in a short time, has no fear of the consequence. — From § 606 to 688 Gaubius goes on to recapitulate the chief varieties of Anxiety.

**XLVIII.** I have by no means said that the pain and pleasure absolutely depend on their being produced in a particular manner, but in general. — It is perhaps obvious that letting down the Impression, from the Painful they become pleasant. Painful is commonly a higher degree of Impression. Force of Impression is a force of Impulse, which has a tendency to destroy the Continuity of medullary Fibre. Gaubius sees the reason why it must be confined to this, in § 672, and endeavours to clear it up though I think he has not quite succeeded. In § 673 he attempts to a more particular account of pain, after all he refers it wholly to Mechanical Impression or Chemical Erosion.

Many cases of Mechanical Impression do not approach



Approach to tendency to Separation - Light appears strong or weak merely as it is an increase or diminution of its present state, for what would now be as painfully strong Impression would perhaps at another time be a very weak one.

In Sound too a disagreeable Sensation may be produced without any approach to Rupture.

It is obvious that pain depends on an increased force of Impression - an increase of force to a certain degree always producing pain.

From a general view of Sensation, and from finding that Force of Impression which has a tendency to destroy the Coherence of the medullary Fibre, we might naturally enough conclude that Pain has a Tendency to destroy the Continuity of the Nerves; but this is observed not to be strictly correct.

Haller is more limited, he takes notice of pain having existed for 40 years, and after all no tendency to Rupture. We find that our Sensations are considered as strong or weak, not in proportion to absolute Impressions, but as these are strong or weak with respect to the strength of the system, as after a person is come out of the dark a small light will appear as strong as the light



light of the sun on other occasions. - Pain depends on a certain force of Impression. It always depends on an increase of Impulse on a particular part of the Nervous System.

Where pain arises from internal causes, it may be often referred to increase of motion; the most common cause is the distension of the fluids, or their Impetus in motion, or the Action of Chemical Acrimony. The Operation of the one or existence of the other in many cases cannot be doubted, tho' it has been often a Query when we are to impute it to the one and when to the other. - With regard to Chemical Acrimony, it has a more considerable Influence than has been commonly imagined. The pain of a Blister generally rises in proportion to the degree of Inflammation, and hence I conclude that the increased Impetus of the fluids has the greatest share in this. If a Ligature be tied slightly round my finger so as to resist the return on the fluids one holding down my hand a pain is caused, which is taken off on holding my hand erect. A pain in the Tooth is often relieved by pressure on the Artery that comes out of the lower jaw.

Heere



Hence it is that a part at one time may be wounded, and be without Sensibility, but on Inflammation become very sensible - The Tooth ache is an instance of this.

The distention of Fluids and chemical Acids being allowed to have a considerable Influence in a pained part, we must allow that there are other causes too, as in Spasmodic contraction of the muscles: As we are ignorant of the nature of muscular fibre, we know nothing of Spasm, we can't say how it produces pain, or whether it be on the general notion of distention, from the cause of the Blood - Spasm is a sort of pain so distinct from the other heads that I am surprised Gaubius has not noticed it.

A 4<sup>th</sup> kind different from these is that which depends on an increase of motion of the Sensory nerves, and that from internal causes propagated along the sensible membranes - an increase of motion in the Extremities of the Sensitive nerves, in the Teeth produced by a shrill Sound causes a pain there - So a Stimulus in the Meatus Auditorius excites a Cough - A Stone stimulating the Kidneys & causing a pain in the Glans is to be referred to Spasm, but to an increase of motion in the Sensory Nerves,

Dr



Dr. Haller has taken it into his head that in the Motory Nerves, the Motion is only from the Brain to the Extremity - In those of Sensation from the Extremities to the Organ of Sensation - But I hope we shall show that this motion is propagated in either direction hereafter. If I tickle my Lip with a feather, the Sensation is made from the Extremities to the Brain and is a Sensation of Impression, but when the same Sensation is excited merely from an appearance of applying the Feather, the Sensation is not of Impression but of Consciousness.

Dr. Gaubius asks whether there may not be Imaginary pains? Does the Imagination excite pains merely in the Sensorium? -

When we have no increased Action of the Fluids, no Suspicion of Chemical Acrimony, or of Spasm, it must often be referred to this 4<sup>th</sup> head - Or when these have existed in one part and are continued to another.

When I have imputed so much to Inflammatory Impetus, I think it not only acts on the vessels it immediately distends, in producing pain; but often communicates it to other parts. - Head aches are mostly considered as external, but they do in the mean



mean time depend on Internal affections of the Brain, very often, seated in the deepest recesses. At the same time there is a fallacy because it may be owing to propagation by means of the Membranes, and to Inflammatory Congestion or Impetus. The Inflammatory Impetus will increase pain to different parts.

A 3.<sup>th</sup> Modification of pain is that arising from Cold. Pain, as in the case of Blistering, may depend on exciting an increased Impetus of Blood in the part, but there is also a pain from the immediate and direct application of Cold - Chemical Acrimony cannot be supposed to take place, there is no Inflammation, no increase of motion in the part, for the effects of Cold are to diminish and take off the Mobilities of nervous power whatever it is.

There is a pressure from the Origin of the Nerves to their Extremities, of which heat is the principal Author. There is then in these a constant tendency from the Origin to the extremities of the Fibres - Cold by stopping this tendency, may cause pain which is perhaps the manner in which it operates. —

XLIX. I before endeavoured to prove that Impressions by being repeated become weaker. —  
Thus



Thus Brandy on the first application to the Tongue gives a painfull Impression, but if the Application be frequently repeated it will be no longer so, but pleasant. Hence pleasant becomes insipid, this refers to (I, XLVII.) that if an Impression becomes insipid we desire a stronger.

L. In considering the agreeable & disagreeable, pleasant and painfull Sensations, I have endeavour:ed in some degree to referr them to the force of Impression - But of some as Fragrant and Fetid, Bitter and Sweet we have no certainty which is the strongest Impression.

LI. This we have examples of in all instances of proportion, especially in cases of Harmony, and perhaps the Cooks know it full well.

LII. The consideration of this has led me to consi:der the operation of the mind as well as the bo:dy; this is a metaphysical subject which I have endeavoured to avoid as much as possible, and have entered upon none that I could avoid.

I have endeavoured to consider Sensation as it first arises without any Repetition or Renewal; The Repetition we in general call Memory; this is in different conditions, which deserves to be distinguished -



**LIII.** Thus, I am carried into an Ante-chamber and told by the Landlord there is a person of such a name within who knows me and with whom I am acquainted; I profess my ignorance; but upon seeing him a Sensation of Consciousness arises that I know him perfectly well, and his name &c. returns instantly to my memory.

We are never very exact in recollecting all the parts of Complex Ideas by Memory alone.

**LIV.** I do not say by what means without the presence of the object, it can be renewed - we shall speak of the means presently - It is with a Consciousness of the Object which formerly excited them. In recollecting the Idea of a substance not before, I am conscious it is renewed without the presence of the Object. The Metaphysicians say it is by a Phantom less vivid than the real Object &c.

We seldom recollect all the Ideas of a Complex Object, and we often perceive we have not the same precise notion of its figure, much less of its several parts. - Every person who seeks for parts of a Complex Idea and can find them upon presenting the Object, sees at once what he wanted.

Before Mr. Harris's time the term Idea was indifferently received both for Idea and Impression. For



Primo Linio. §. 559.



For Impression I substitute the term Sensation.

I have to avoid cavalling employed the general term of Notion as comprehending Ideas and Sensations; by fixing the term Idea we fix Memory more strictly in opposition to Reminiscence and Imagination.

**LV.** This happens in Dreams and Deliriums and is by the power of the Imagination.

It may be thought I have been bold in limiting the term Imagination, since it is one that is so vague and undetermined hitherto. But Haller has endeavoured at it likewise - Milton too has hinted it in his Samson Agonistes.

We employ Imagination for an exercise of the Memory which when it is very exact in remarking the particulars of motion, is called the force of Imagination.

**LVI.** Memory is no other than Association. Those Ideas which immediately succeeded each other, and were commonly impressed on the mind at the same time, and those notions that are referred to one and the same object are afterwards so united that the Renewal of the one serves to renew the others which were made nearly at the



the same time; But independant of their being in the same subject and in immediate succession, if they be such as we have remarked a relation between, the presence of the one renews the other. And Memory is no other than a renewal of the other dependant on circumstances.

We often speak of the Treachery of Memory failing to bring back objects in point of time and place; but we have in general no memory when we have it faithful.

One of the first foundation of assent is that merely in point of time. The order of time then is a very considerable point, and our memory is faithful to this. — We know how much it disturbs it when our memory is not allowed to follow actions in their wonted order.

The number of our sensations that arise from other bodies in particular situations are considerably lessened, some in the same order & connection and leading to repetition — There is then an usual train of acting and thinking with respect to our Mind.

**LVI.** This is a proposition very difficultly admitted unless considered — It would be difficult



difficult to say we do not recollect the Smell  
of the Rose, and Taste of Wormwood - But Dr.  
Haller in (558) toward the end is of this opinion,  
as are most other Metaphysicians & Philosophers.  
- The Taste of any particular food I do not recol-  
lect, but the Company, the Expressions &c. which  
were made at the time the Impressions were  
made. Of Sugar, and wormwood, I recollect that  
the one gives me pleasure, the other pain; but  
it is very happy for us we cannot recollect the  
severity of pain we have at times felt, but we  
cannot recollect certain particulars accompany-  
ing it, which makes me shudder, at the same  
time we cannot bring back pain in a particu-  
lar part. I think a Woman who has born Child-  
ren, if she could recollect all the circumstances  
of pain accompanying it, would resist the grati-  
fication of the pleasure she might otherwise in-  
dulge herself in.

The last part of this is particularly related to Im-  
agination - I cannot recollect the Taste of Specacoanha,  
but to certain persons the sight of it will renew the  
Idea of Nausea & Vomiting.

It is said that the sight of a purging Potion to  
some persons will not only produce Nausea and  
vomiting



Haller. P. Lin. § 561.



Vomiting, but will go so far as to produce Purging—  
tho' this is not in the power of Imagination. This  
I suspect then not to be true, but the Love of the  
Marvellous has carried it farther than it ought  
to be.

**LVIII.** If we have any Memory immediately  
after Birth, it is very limited—The same in the  
decline of Life—In the progress from Youth to Man-  
hood Memory advances and grows stronger, and  
declines as old age comes on. The two different  
periods are attended with different circumstances.  
In the decline of life Impressions made in the vi-  
gor of life are remembered, whilst those that were  
made yesterday are forgot. From hence it appears  
that the state of Memory has a progress to 30  
years, and is somewhat stationary to 50, and then  
declines—It likewise is different in different per-  
sons, whilst one person retains a million Ideas  
another man scarcely retains an hundred.

There are different kinds of Memories too—dif-  
ferent men are disposed to receive the same Im-  
pressions with different force—One man is disposed  
to mark one kind of relation, another those of a  
different kind—In this consists the difference of  
Geniuses amongst men—One person marks the  
point



point of Time, another the Association. One person will repeat exactly 100 words that have no connection with each other, which is more strictly by the effect of memory, not of Judgement - thus it is said that great Judgements have little memory, because he overlooks the lesser Associations of words, signs, &c, and marks only the more material and general ones. But there can be no great Genius without a strong memory, <sup>by</sup> which he is enabled to associate a great number of Ideas, perhaps in different order from that in which they occurred.

What relates to decay of memory in old age and from ~~other~~ accidental causes, seems to be thus, sometimes we recollect circumstances by signs, and when our memory begins to fail we lose our recollection of these first. Thus with respect to myself the persons whom I knew when young I can immediately on seeing them recollect their names, but those I became acquainted with lately, tho' I know their faces perfectly well, I am at some loss to recall their names.

The last state is the loss of Reminiscence, when we not only lose the name, but forget that we have



Halleri. P. L. J. 560.



have even seen the Object before. A person of a good memory may lose the reminiscence of an object he has not seen for many years; but if he forgets his own family and those he is constantly with, it is a total oblivion.

There is a power in wine to improve a man's imagination and memory; this if carried a little farther than its dose will procure a perfect oblivion. We have many instances of loss of memory in all its different degrees. Several Theories have been attempted on the subject of memory—Dr Haller has supposed it proceeds entirely on mechanical principles, tho' I don't think this will apply to many cases of memory. It certainly is connected with the Sensorium in a certain degree. This is universally allowed by Physicians. A change in the Brain causes an alteration in the rest of the body and soul, and consequently of Memory amongst these. Haller supposes there always remained something of the same Sensation that excited it first [Haller § 559. 510.] But I think that neither Haller nor any of the other writers go any particular lengths and therefore shall not follow them.

The four next Arguments have been taken notice



noticed by every Metaphysician.

**LIX.** This a general proposition which is not brought out fully or clearly. There is one usual and common impression as the foundation of all our sensations: Thus Light is almost the only foundation of our sensations of Light within, but without Light, as by pressure, a blow &c a figure of Light, as Mars &c will be excited.

The same of Sound; almost the only way it is communicated is by the Auditory nerve vibrating to the sound, and hence it is that Tremors communicated to the Teeth sometimes supplies the defect of Hearing. Dr. Haau (author of the *Impetum faciens*) wrote that he could at least feel Sound.

When we have a sensation ascribed to a particular mode of Impression, suppose the same arises at any time, is it from the same cause? We spoke of this when on the subject of Chemical & Mechanical Stimuli, and it is therefore not worth while to resume the subject here.

When a person falls into a *Deliquium Animæ*, a particular noise is heard in his ears. I do not doubt but this came from Impressions first made on the Sensorium, but they are Sensations of the Imagination — we suppose that they are from Impressions made directly on the Sensorium. —  
Inc



In most cases where we find false Imagination there is a Sensation or Idea of the presence of the Object. It is very rarely where we have had occasion to examine the Sensorium under this disposition but we found a change, and this change so like in all similar cases that there is no doubt but this gave occasion to the new motions produced. In most cases we can discern that there are in proportion to increased motion or impetus of the Brain. These arise from an Impression first made on the Sensorium, but the greatest part of this must be referred to the Pathology.

In the case of Sleep there is a total Interruption of Memory; we can perceive however that between this profound Sleep & waking that there are various intermediate states. Many of the Obstructions betwixt the several parts of the Sensorium, appear on dissection to be partial affections only. At first I put Sensation & even dreams down as owing to Impressions made on the Sensorium; but this is not strictly true; it may be from Impressions made on other parts of the body; thus dreams are commonly owing to an uneasy posture, the state of the Stomach &c.

Upon this subject a question arises whether dreams are only a renewal of former Ideas, or a prophecy of future events? I think the former.



To what length do these renewals proceed? Or do they renew more strongly the Sensations, Taste, Smell, & Touch? Can we give the renewal of pain? Dr Gaubius is of this opinion & it interests us to determine it.

By Motions made in the Sensorium, similar Sensations can be produced with these from Impressions made on the sentient extremities. This is the power of the Imagination.

In Delirium we see an increased Impetus of the Blood to the head. Dreams in this case we can find evidently depend on the state of the Brain for the time, but it is not direct impulse alone that will thus produce the sensations of Imagination. It does not depend on the force of that Impulse, but on a certain condition of the Brain necessary to be connected with it. The Brain is a part which has Communication between its several parts; for the Exercise of its usual train of affections, it is necessary that it be free & uninterrupted in all its parts. It would seem that Dreaming is attended with this partial Interruption, which is the foundation of that Irregularity which occurs. Dreaming is neither Memory nor Imagination, but a Representation of Res coram gesto.

In



Gastrii Pathologia § 67A.



In Pathology we find that in order to produce Delirium there is no occasion for the Impression to be made on the Brain itself, but if it be made on any other part & thence communicated to the Brain, it there excites imaginary Ideas— This consideration leads us to enquire whether in the case of Imagination, dreaming or Delirium give new Sensations, or only a renewal of Sensations formerly received. I told you I would not pretend to determine this any way.

Whatever opinion we take if we view it in a religious sense there is no refusing that other Spirits may act on ours; but it is to be presumed that they do not give new Ideas, but conduct the Understanding &c

With respect to Physic. I am inclined to think what occurs there is chiefly a renewal of Sensations formerly excited there. Whilst in dreaming I recollect the objects of Sight & Hearing, I do not recollect ever to have enjoyed Taste or Smell. I premise this, whilst I say the question goes still farther. To what length is the renewal of Ideas made in consequence of Imagination? Gaultier's opinion on this head led me to this. If Pains are really imaginary, we shall be often at a loss in our Pathology. In Hypochondriacs  
(we)



Laub: Path: §. 685.



we believe there is really a pain felt some where.  
— I suppose Dr Gaubius on this head has been de:  
ceived with an Analogy. I once dreamed of a pain  
in my breast, but on waking really felt one there.  
The Analogy he mentions turns on the former ques:  
tion of what sensations can be renewed? But all  
Physicians have agreed that we cannot renew pain.  
If this be the case this Analogy exposes us to de:  
ceit, and as I do not think that either in dreams or  
deliriums we can feel pains unless they really exist,  
therefore would apply the same to Anæsthetics.

I allow that many sensations may be renewed, that  
many may be actually produced by sensations made  
on the sensorium; but that these motions can com:  
municate other motions to very distant parts of the  
system. I have been shewing that motions or Im:  
pressions made on certain parts of the body do not  
produce pain there, but in distant more sensible  
parts. The sensation may be either of Impression or  
consciousness, as it only produces these motions by  
acting on the sensorium, which producing other mo:  
tions there they may be extended to very distant  
parts.

**LX.** I would wish this had been entirely omitted.  
The first part is too generally announced.  
There is nothing more generally received amongst  
Physicians



P.L. § 563.



Physicians than that the Exercise of the Mind depends entirely on the state of the Body, in so far that from the state of the body we may often reason on the state of the Mind, and the diseased mind has a correspondent state of the body on which the Physician must operate.

It is this correspondent state of body and mind, that has afforded foundation for the doctrines of Materialism, and some persons on this account have avoided touching on this more intimate connection. But the Stahlians allow a corporeal connection to a certain length.

Another Physiologist says that not only a sensation on the extremity of the Nerve is necessary, but also a motion propagated is necessary, & when our sensation produces another it is by means of a motion propagated to a different part of the brain — but this makes no difference with respect to Materialism. — Some mental operation is in either case necessary.

Dr Boerhaave is very pointed in this respect. —

Dr Haller is equally so, but thinks there is still a mental power *ab omni facultate corporeâ remota* —

Dr Gaubius is of this opinion too. §. 523.

If too much be granted for the sake of religion

we)



we have done with all reasonings in Physic.

LXI. This may seem at first in opposition to Dr. Whetl's opinion, but as he maintains that the sentient principle is always given, it does not affect it.

When a muscle is cut out of the body some, with Dr Whist, imagine the soul is still present as long as it is capable of motion; but I look upon them to be then merely corporeal. Here stimulus will produce contraction by the same Mechanical means, only this is never attended with consciousness, we have too some sensations that are attended at first with consciousness, which by repetition is entirely obliterated. — It is possible too that a person may be grown up to full memory & consciousness, and yet has no sensation of a dose of Physic stimulating the Intestines till it comes to the Rectum.

In general the                                  such as the Operation  
of pressure is purely of the mechanical kind.

Many of the Motions of the Body arise from the Sensations of Consciousness; the passage of the Blood through the Lungs is uneasy to me, it produces a Propensity to Sighing. There is no sort of doubt but motions in the Stomach do not always depend on Impressions, but sometimes too on a Sensation of Consciousness.

Wherever



LXXI Whenever the contraction of animal bodies is observed & of a particular kind which we shall presently explain, there are particular organs to perform such motions, we can for the most part discern such Fibres, & presume them else where. They are in different circumstances and conditions, in many cases collected into Fasciculi; where a number of those are collected in a more compact manner into larger Fasciculi, we give the name of Muscles.

In many parts these are inlaid in Membranes remarkable for breadth rather than thickness. — We can frequently observe them collected into Tendon. (Wherever we observe such contraction performed as in the more noted ones, we conclude *a priori* the presence of Muscular fibres.

There is a difference of Colour in Muscular Fibres, Haller takes notice of it, but we perceive on washing out the blood that the fibres become white or pale, & we have them in all their varieties from the large muscles to the Vesica Urinae. The difference of Colour then does not imply a difference between the moving fibres — we are not then to enquire for any such, and the term moving & muscular fibre is to be of the same import.

Dr. Boerhaave, in the Irritability of the Arteries, finds  
some



some difficulty in reducing it to the ordinary appearance of these Fibres, and he hence concludes a difference: Thus the contractile fibres of the Vesicularine are indeed more closely compacted together, than the moving fibres we know of else where. If the Tendons are a continuation of the muscular fibres, & the muscular fibres are in course of life changed into Tendinous, if these are to be admitted we can perceive that this change from muscle to Tendon must be by degrees, whilst Muscles they have the whole of their Contractility, but when Tendons lose it altogether. But it is easy to perceive that there may be an intermediate state between these two extremes, which may be the case with those of Arteries, but does not infer that those Muscular fibres are different from these else where, but as I have already said from being of an Intermediate State.

**LXIII.** In Animal Bodies there are different kinds of Fibres.

1. Simple solid fibres, as they appear in ligaments, Tendons, &c.

2. I would call the Nervous, as in the medullary substance of the Brain, & that takes place in the Nerves more strictly so called, and sometimes in expansions



Pathol. §

LVIII



expansions of the extremities of the nerves more strictly so called.

3. Muscular Fibres, these are of different structure or organization. The simple solid fibres not being liable to sense & motion may be different merely from a different substance composing them - if not to a difference of substance they will lead to a difference of organization - Dr Haller has supposed a particular Gluten in muscular fibres; but this opinion is not sufficiently supported. In these two there is probably a difference of organization; but in what this consists we cannot say. The one is incapable of that contractility which so remarkably distinguishes the other.

Dr Haller formerly imagined the nerves were affected with contractility, and has given a Dissertation to prove the power of the Nerves on the circulation by this means - But by no stimulus, Mechanical or Chemical can any appearance of contraction be produced unless by the contraction of Muscles.

Dr Gaubius has a paragraph which might disturb us; but with regard to this I shall shew hereafter that this may be explained in another way, because it is very likely deduced from reasoning, not from experiment, and hence will admit of another meaning  
with



with greater probability. Therefore the Muscular fibres are distinguished from Nerves by the Contractility which must infer a difference of Organization. It would be disagreeable to run over all the Conjectures that have been made on this subject. — Former Microscopical Observations founded upon Hypothesis say a Fibre is composed of vesicles, but Haller & others do not confirm this, and the last Observations we have, viz. those of Mr. Mury, are that there is no peculiarity of structure, and that they appear <sup>an</sup> uniform cylindrical cord throughout; but he says else where they appear intersected. — The Physiologists who suppose the Nerves hollow canals have had recourse to the Influx of nervous fluid. — others who suppose them simple solids, imagine their Contraction is merely from being in a contracted form. It might be best explained by this, especially as the latest observations described the smallest Fibrille of a muscle as constantly of this form — But still I conclude as in the Paragraph.

**LXIV.** Different from all Elastics we know except some vegetables & all Tendons and nerves amongst these. — It differs as affected by causes which do not affect the others. — It is excited by extension in common with all other Elastics, but it differs in so much that every other Elastic that is extended continues



continues there, and only shews it's Contractile power on the stretching power being removed. — But muscular fibres act, whilst the power that extends them is still present, instanced in the ventricles of the Heart, which act when the stretching power is applied with full force) — Except it may be something which may occur in vegetable fibres of a like Nature in no where else in Nature do we meet with a like property.

There is, with regard to common Elastics, no power that will excite their contraction (except Heat & Cold) but Extension. — But this is not what alone acts upon Animal Fibres. — Heat it is true is a Stimulus on them; but a sharp pointed Instrument will not produce a contraction in vegetable fibres or any other Elastic whilst the stretching power is applied, except on Muscular fibres alone. — Extension, Heat, or any power capable of exciting the Contraction of muscular Fibres, we call Stimulants.

**LXV.** In this it is very different from other Elastics whose Contraction is very nearly the same as that of the powers applied to extend them. — very different is the force exerted in the Contraction of muscular Fibres from that applied to extend them



them. The force exerted by the motion of the heart is far greater than that of the venous blood extending it, for which see Dr. Hales's Experiments. I might say with regard to other Stimuli that this difference is far more considerable, whilst the motion of a muscle is equal to 100 lb the point of a Needle is sufficient to excite it - By this is Muscular motion to be distinguished from any else. -

The other is the degree of contraction produced, but without knowing the peculiar structure of Muscular Fibre I don't know that this will apply here. Perhaps other Elastics will contract to equal degrees of Contractility, and of such Elastics we have new instances every day. These not only contract to their wonted place, but in their subsequent Oscillations contract even farther. I am now hastening to explain the several terms we must employ.

**LXVI.** Here a difficulty occurs, in what Life consists, and the precise Limits of its duration in Animals - Any settled Limits we have not arrived at. - We can say that Circulation is so necessary that life cannot exist long without it, But we cannot say this with respect to all Animals, for in some when cut in pieces &c, they live - in others the Integrity of the System is necessary. - So far as we have



have any means of Judging, the duration of Life depends on circulation; in many cases where the Muscle is cut out and acts, this action is of very short duration, & equally so when the communication between this and the brain is interrupted whether by suction or by pressure.

That is never excited but with life is never so easy, but from several Experiments & Observations there is reason to suppose that there is the same contraction as soon as life is more evidently excited, and hence Gaubius has called it a vital power, & so he may be excused for calling it a *Solidum vivum*.

**LXVII.** A muscle cut off of the Body & separated from all the powers of the System, for a time retains this power of Contractility — Hence Dr. Haller and others have supposed that whatever Connection it may have with other parts, it still independantly passes contraction. How far this may be true we shall take notice of hereafter.

Most of the Operations of the Animal body depend on Muscular motion, & there is no doubt but more of these would be explained if we could but become acquainted with the structure whereby they are regulated — I shall not pretend to remove the difficulties, but



but there is much Temptation to endeavour to understand the Laws whereby they are regulated, or commonly governed; and for this it is necessary to consider all the circumstances attending it.

With regard to the Nervous System or any Theory we may adopt, the facts are the same.

There is but one object in view one kind of moving Fibre—So far as our Observations have gone there is a striking Similarity of the Muscular fibres not only in the same Animal, but of different Animals.

In the next place we presume that this Muscular fibre has its properties dependant on its peculiar Organization.

We shall here premise that there are three kinds of Fibre, that of the Muscles, of the Nerves, and of the Simple Solids.

As Motion is excited differently in the Muscles from what it is in the Simple Solids, perhaps we may conclude that they are different.

The Action of Muscular Fibres considered in itself is its Contraction, but it deserves to be considered more accurately in Experiment. If a Feather be dipt into *Ol. Vitriol*, & applied to a Muscle, a Contraction is produced. We have here to consider that



that this sort of Contraction is by affecting the Mixture or Aggregation of these Bodies; and we refer Contractions by heat to the same head: Thus if I hold a piece of paper to the fire it will be warped; this is owing to the Vaporization from its surface, which makes the other side contract. There are several other instances where we can perceive a Contraction from a change of mixture.

Another kind of Contraction is that of many bodies that allow their Figure to be changed—Their Dimensions are increased, but on removing stretching powers, these Bodies show a power of returning into their proper places.—This is not a change in their mixture except in so far as it can be acted upon by the power of cold.—Cold perhaps increases that power by which the particles of bodies are brought into nearer contact. (It is for this reason we are to distinguish the Contraction of Animal Fibres because they take place independent of the change of Temperature.) There are the only Contractions in inanimate matters, and hence I say that the Contraction of Animal Fibres is different from the Contraction of all other Substances in nature, (except vegetable fibres which have

a)



a contraction as difficult to be explained perhaps as Muscular motion.) How far animal & vegetable contraction differs I shall not at present enquire.

There are 3 circumstances in which Animal Fibre differs from the contraction of common Elastics.

1. Like them it is excited by extension, but acts whilst the stretching powers still continue applied. The Heart is excited to contraction by influx of venous blood, which continues always constant & uniform, & thus the contraction of the heart takes place whilst the stretching powers are applied.

2. By various causes which do not act on other Elastics - There are no instances of Mechanical or Chemical Stimuli exciting the contraction of Elastic Bodies. (Electricity acting so particularly on Animal bodies may have a peculiar one with respect to other Elastics.) - (With respect to Chemical Stimuli some have thought they act by affecting the mixture; but in Animal Fibre this cannot be, for we perceive common Salt is a more powerful Stimulus than Aq. Fortis.

3. The force of contraction is greater than the force exciting it - I gave an example in the force



force of the contraction of the Heart. The force of the venous blood is greatly short of the Momentum excited in the Contraction - And tho' in some cases the force of Contraction of Elastics may be greater than the force of Extension, yet it is nothing to that excited in a Muscle. What proportion does the force or momentum of the point of a pin bear to the force excited in the Contraction of a Muscle.

It is peculiar to living bodies. It is true that a portion of Muscular fibres entirely unconnected with life, it does exist for some time, and it may be doubted if it would not exist a much longer time if heat & humidity were continued to be applied. Even it's existence for any time consists in the powers given it by life, that is only produced by life, whether you call it life or the living Soul, it appears that it's first effects are by exciting the Contractility of Animal fibres, and from this first begun proceeds all the others, and hence is to be distinguished from all other substances in Nature.

The Contraction of Elastics is only excited by Extension, on removing the stretching powers they return to the same place. - It is plain that the Elastic will always allow this - In the state of



of Peristole the Venous blood is applied to the Heart, it does not then return to its former place but much farther.

As in a portion of muscular fibres cut out of the Body and without any communication, the Contractile powers still remain for sometime in some circumstances inseperable from it; and this power having been observed in Muscular Fibres independant of any thing else, it has been called a *vis insita* or inherent power. the only mean here to explain the term, the supposition being given.

**LXVIII.** The Nerves belonging to the Diaphragm can be examined along way before they arrive there, if we irritate them any way their whole length it excites a Contraction tho' at the distance of 5 or 6 Inches. Motion is communicated by means of Impulse, and there is no Impulse but what is propagated by means of Continuity. As I said in general we may take any supposition, as to the Nerves being Tubes & emptying a fluid into the Muscles, or to their being Elastic and giving Oscillations to excite a Contraction. The general conclusion of a Motion being propagated will easily take place. — It is by no means by destroying



Destroying the function of the Nerves that Ligatures act. For tho' an Impression above the Ligature cannot be propagated, yet the effects will still visibly remain if the Nerve be punctured below the Ligature, by a contraction taking place in the muscle.

Possibly the puncture of a Nerve is always attended with a Sensation of pain - when we have applied the Ligatures nothing is more clear than that this motion is in some degrees mechanical. When it appears below the Ligatures it is to me clear that it acts independant of Sense & Reason. It is by Dr. Haller called an Accessory power. Whilst the Stimulus applied to the Muscle itself produces the same effects as when applied to the Nerve. - He says the power from the Nerve is, different from the *vis Insita*, I employ the Nervous power as a power in the Nerves strictly so called, & I mean to distinguish it from a power in

**LXIX.** From Experiments like these I have mentioned just now, we can plainly perceive that this motion from the Brain to the Muscles can be excited by Stimuli that act not directly on the Nervous powers more strictly so called; it may be



be by applications to the powers of the

but Stimuli can also be applied beyond the Brain, to various Sensory Nerves to which motion can only be propagated thro' the Brain. Independent of Simple Impression a peculiar Modification occurs in the Brain, by which it acquires stronger powers.

Besides the *vis Insita* we can observe that by motion excited in Nerve, the muscle connected with it can be urged into contraction - this is by means of the Nervous power - Besides this there is the Animal power, where the Will excites the Contraction of Muscular Fibres it seems only to do this in so far as it gives motion to the Nerves - But the Will only acts in the brain, & producing a motion there which running along the Nerves gives motion to the Muscles. - The Motion in the Brain depends on the Brain in great part, & is by no means a purely corporeal matter; but here I would observe that when a Stimulus is applied to any part of the Medullary Substance of the Brain, that this is exactly analogous.

In the Will there is a peculiar Modification arising from Sensation; this we supposed connected with a peculiar Organization in the Brain. -

Hence



Hence on certain Impressions & in certain states of the Body (analogous to LXL) we may not be sensible of them. There is then a peculiar condition of the brain that modifies various Impressions, which modify motions excited in the Brain & communicated to Muscles; this I call *animæ* powers. — Animal powers viewed in this sense throws light on Muscular Fibres.

**LXX.** It is evident that Infants are more moveable, more readily excited than Adults. The same applies to the comparison of the two Sexes, the Female being much the more moveable.

With regard to the occasion, we find that most instances of great Mobility are connected with considerable weakness, therefore they are two different conditions of muscular fibres, or of the powers exciting them. Whether greater Mobility be accompanied with greater force of Contraction I shall by no means determine, nor shall say whether are both affections of the Inherent power, or of the Animal powers.

Mobility is a very good term — Contractility I am not satisfied with, perhaps it ought to be the power the force of Contractility. — With regard to Irritability the Stahlans have always employed it



it for the contraction of muscular Fibres - Dr. Gau:  
:bies merely the facility wherewith Muscular  
fibres are excited to contraction. I might per:  
:haps employ Irritability in this sense, but Gau:  
:bies also employs it for the excessus vis vitalis.  
But this is losing sight of the distinction we  
have been endeavouring to preserve, for it  
may be considered as an excess of Mobility, or  
an excess of Contractility. That there are in:  
:stances of the last I refer you to Maniacs -  
This I allow may in some cases be joined with  
Mobility; but commonly it is so far from this  
that they are not sensible to the same Impressi:  
:ons as in health, as in their insensibility to cold  
and the operation of Medicines.

The distinction is just & different terms should  
be applied. - Torpor is opposite in most respects  
to Irritability, especially as an affection of Mus:  
:cular Fibres, but is very improperly applied in  
many cases to an excess of the vis vitalis. The  
Torpor of the Fibre is often connected with Insensi:  
:bility & Stupor, hence I think we shall have oc:  
:casion to distinguish them.

LXXI. This is sufficiently evident so far as we  
can



can distinguish them, we can observe they are operated upon by different causes - They can be acted upon by poisons as the Rabies canina - Opium and some other powers can diminish the mobility, the strength remaining the same.

The means of increasing the mobility are perhaps few of them distinctly known; we have confounded them probably under the general head of Stimulants.

We have a term tho' that we apply more accurately to those that diminish motion, viz, Sedatives. - With regard to Contraction there is not any term that comprehends all the different powers that weaken it. But there is a term that contains all that strengthen it - These we call Tonics.

**LXXII** The term is here supposed because I find it difficult to establish the fact. I have just observed that the force of Contraction is stronger at one time than at another; whatever is the difference of Circumstance we can observe that it takes place thro' the whole of life, in characterizing the different circumstances of Contraction as different in different persons: so in different parts of the System there may  
(be)



be difference of strength of different fibres in one part of the body than in another - This is a supposition & know no proof for it - The mobility is the chief difference in the inherent power - Different muscular fibres are connected with different organs of sensation - We have explained in what circumstances they are different, hence in so far as the organs may be of different degrees of sensibility, the muscles may be more or less mobile.

When the bladder is in a contracted state, it will not be sensible to contraction by stimulus, yet if it were extended it would - its vis inertia is then the same.

When the Strait muscles do not contract soon after death, it is perhaps on account of the force binding them down; if free it is possible they would shew the same mobility as the heart.

The Nervous Influence seems to depend more or less on circumstances of heat, the drying, the coagulating of oil, &c. Whilst these doubts remain tho' I can make many conjectures with regard to it, all the conclusions must be taken as doubtful. While they are more moveable the Inherent power is more perceivable.

after



After Life is destroyed, the mobility is different in different parts, & in different Animals. In those of Cold blood & the Amphibious it remains longer than in those of warm blood. This certainly shews that the Contraction of these Animals are under different circumstances, & under different circumstances with regard to heat. In warm Animals we can conclude that when the Heat is below the temperature of the Atmosphere, that Irritability & Sensibility is decreased. But supposing we can shew admit a general difference, is it presumable that this is different in different parts of the same Animal? In some cases tho' the Intestines retained their Irritability a long while after the heart, it was in all probability depending on this circumstance that the last was exposed to cold. The Intestines are a large mass, and wide on this account keep their heat longer than the heart if separated from the lungs; but if they were kept together it is possible they might not have shewed the same event. On account of the Inaccuracy in this respect, the question with respect to the greater or less Irritability has not been sufficiently examined.

LXXIII. We now come to the question how far the Inherent & Nervous powers are of the same nature?

Eno



In Dr Smith's Observations he has shewn in a great number of Experiments that it is a matter of Indifference whether you make the Application to the Nerve or muscle connected with it, the same Stimulus acting in either case, whether Mechanical or Chemical.

But with regard to diminution of Irritability, this arises especially from his Experiments, a great number of substances destroyed the Irritability, no matter whether directly applied to the Nerves or the Muscles to which it led. We know of many Substances that by being applied to the Animal or Nervous powers have this effect. Most part of our Sedatives are only applied to a small part of the Nervous System, but as they always produce the same effect, we conclude they are of a common nature, and that they always affect the same substance.

LXXIV. It has been supposed by persons who thought these different, that the Nervous powers might be then as a Stimulus acting on the Muscles; but if we find that the Action is mutual, and that the Action of the Muscular fibres does affect the Nerves, we cannot doubt of a continuity - Muscular fibres are sensible to Impressions, and in many cases Organs of Sensations of Consciousness - the Mind being conscious of the different States of Muscular fibres, their



their contractility &c. is another reason why motions are propagated by the muscles along the nerves to the Sensorium.

**LXXV.** As there is a communication of motion between the one and the other, & a likeness of motion, I offer this as probable.

**LXXVI.** I now go on to obviate the Objections made to it. This is an Objection (Argument) employed by Dr. Haller. The question is, whether the *vis Insita* of Haller be different from the Nervous as he calls it. That the Animal & Nervous powers depend on motion of the same kind of matter, is, I think, beyond dispute. With regard to the Inherent power if it be proved that the muscular fibre be a Continuity of the nerves, it will be conclusion that they contained the same kind of matter that is in the nerves and Brain; but this fact can by no means be made evident to the eyesight, if we suppose it, it must be established by reasoning. I have given it in part.

I have employed two different Arguments, As we observe the same appearance whether the application be made to the Nerve or to the Muscular Fibre, we conclude that there is the same kind of matter in both. Thus a Needle produces the same effects whether applied to the Nerve  
or



or the muscle connected with it.

Salt applied to a muscle or it's nerve excites the same contraction. The effect is the same in both cases, but the Argument here becomes stronger. If the operation of Salt be a chemical Impression or something analogous to it, it will be highly probable that the common Salt finds the same matter on the Nerve and muscle to act upon.

3. From the Action of Sedatives. — When the effect of Applications is to diminish motion it is difficult to conceive Mechanical impulse having this effect: It should depend on a change of the state of the Matter analogous to the Operations of a particular kind of Matter.

There may be here a Subterfuge that in fact we find mere pressure has sedative effects in diminishing the mobility of the Nervous power, and acts both by Concentration of the Nervous & Muscular fibre. The Saline may act here merely by producing a contraction of the Nervous or Muscular fibres. Enveloping membranes which are composed merely of simple solids.

When Dr Smith found that Sacc: Satur: applied to the Membranes proved Sedative, it may be

(said)



said that it is by constringing the membranes and hence affording pressure; but this is but one supposition against another. But when Opium in small quantity produces its effects all over the body we shall find it difficult to account for its effects all over the body by pressure; more probably it is by acting on a particular Nervous substance. — Haller himself allows that Opium destroys Irritability — This not connected with any particular notion with respect to the substance in the Nerves. — It is only that whatever be the substance in the Nerves it is the same in muscular fibres.

As muscles are sensible to impressions, and if the puncture of a muscle gives the same sensation as in a nerve, with the same effects, I conclude a sameness of substance. — You may say that a very minute portion of Nerve is distributed all over the muscle, & hence the effects of Puncture may not be by producing the effects on muscular fibres being Organs of Sensation with consciousness. — In consequence of their being contracted with uniform force, & of their being stretched universally, they give occasion to Sensations of a particular kind. — This cannot be supposed without a continuation with



and that it is by contracting the muscles  
and hence opposing pressure; but this is not  
an opposition against another. But when the  
muscle is more strongly produced its effect is  
over the body and therefore it is difficult to account  
for its effects etc. over the body (by pressure).  
Hence, perhaps it is by acting on a substance  
through distance. Matter himself allows that  
from distance is not possible. This is not connected  
with any particular matter with respect to the  
substance in the force. It is only that substance  
in the substance in the force it is the same.

3. Muscles are capable of impressions, and  
the function of a muscle gives the same force  
as in a force, with the same effect. I conclude  
a substance of distance. For say that a  
very small portion of matter is situated at one  
the same place the effect of distance may not  
be by producing the effect in muscles, but  
by organs of distance with the same effect.  
Hence, perhaps it is by acting on a substance  
through distance.

Prima linea



with the Nerves - hence I think the Muscular fibres are a continuation of Nerves in every other part of the System. - This brings us back to the

LXXV Paragraph, which will be better understood from what has been premised. If it shall be concluded that the fibres of ~~Muscles~~<sup>Nerves</sup> pass into the Fibres of Muscles, and if this is to be on the supposition that the nerves are hollow canals, these passing into the muscular fibres it will follow that the muscles are a continuation of these hollow canals - or nerves.

If it shall be found that it is continued to muscular fibre & does not pass readily & freely into any other, we shall infer the continuation more especially - hence if there be an inherent power it is very much of the same nature as the Nervous power, and that it is the same matter moved either by the Applications to the Nerves or to the muscles.

Dr Haller has taken much pains to establish the difference between the vis Nervea & the vis Instinctiva: if his doctrine be well founded it will affect many other fundamental ones in the Nervous System. - We shall examine his AOA Paragraph - Having in the AOB Paragraph given an account of



of the Nervous power, he goes on in the 404 to shew that the Nervous power & *Vires Inscitae* are not the same. A great deal of Argument runs upon this, that Sensation and muscular motion are very different: and we never taught it - the one is confined to Muscles, the other limited to the brain as its proper Function. But is there not in the Brain and Muscles a matter of the same kind which, variously modified, give occasion to Sensation or Contraction?

We shall examine his Arguments separately, and begin with such as may lead us better to understand what may follow.

Movetur, quod sensu caret. In this he is indistinct. I do not know any one muscular fibre that is not sensible; or that in consequence of various applications to it does not give occasion to Sensation. Dr. Haller himself supposes this in another part but at other times keeps it out of sight. In the 12<sup>th</sup> section of his 10<sup>th</sup> Book - with the half exception of Arteries, which we have spoken of already, he says Muscular Fibres are exquisitely sensible. He means here only to say that Muscular fibres retain their inherent power when cut out of the Body, and can be no longer subject to Sensation - This is strictly just & true if we with him believe that  
Sensation



Par. 10. Sect. 2. Libr. 11.



Sensation can only arise by a motion communicated from the place of Impression to the brain, which if it be cut off there can be no Sensation - but if the same kind of motion be produced we presume it is from affecting the Nerve. - If there be the least Argument suspected here let us apply it to the Nervous power existing below a ligature or Section. Here we may say that in this part of the Nerve there is a power, but it is not the same with the vis Sentiens. - After the Nerve or muscle is cut from the Body it is not the same, hence this vis Sentiens & vis Nervosa are different - Haller uses the vis Sentiens & vis Nervosa indifferently.

Dr. H. - Sentiunt corporis partes quae sunt absque motu. When a puncture is made on a Sensory Nerve, it gives a Sense of pain, & when a like puncture is made on a Motory Nerve & gives occasion to the motion of a Muscle - No supposition can arise of a difference of Matter, for in the same Nerve you may produce both Sensation & Contraction. - If you apply it to a Motory Nerve which in a living body is always connected with Sensation, it may act on the one by its peculiar Organization, and on the other by means of its constant effect. It is connected no where else with a peculiar Organization, & the different effects may be fairly resolved into a difference



difference of Organisation.

The other Arguments may be discussed more shortly.

**LXXVII.** The whole of Dr Haller's Arguments, a vincolo Nervis injectis, - a leso cerebro a propinato Opio, amount to this, that he only concludes that the Animal & Nervous powers are not necessary to every contraction, but that the contractile power may subsist without it. - This may be, without allowing to him that they are different.

All Dr Haller's reasoning is founded on facts not fully established. - With respect to Opium destroying the motion of the heart, it is fully proved both by Dr Whist's & Dr Monro's Experiments on this subject. Dr Haller will not advance that the Vis Insita of the heart & Stomach is different from that in other parts of the Body - the utmost will be, ~~per~~ in degree not in kind, and hence if Opium will destroy their motion in one case, it will also in another.

Argut in Animalibus cerebro destitutis. - But this has not been allowed, some we cannot find on account of their smallness or transparency, or peculiarity of figures. - It is not necessary for a brain that it should be collected into an Incephalon, for from wanting this peculiarity nobody can infer that there is any Animal without a brain or something analogous



analogous to it as a means of Communication between different parts of the System. — Haller complains of Dr Whist's alledging that there is a brain in all Animals without giving evident proofs of it; but Dr Haller is equally to blame for founding it on a negative which can't be proved. There is no Animal we can examine fairly but what we can discover a brain in, and in many which were formerly thought to be without any, now on a more accurate Examination we find it: thus Haller denies it in the Vermes — these are now found to have a brain. These are one or two parts not founded on facts. — Here the Conclusion is so far just that the Animal power of the will is not necessary to every contraction. — This is against the Stahlians & Dr Whist who maintained the Universality of the presence of the Sentient principle, whether the application be made to the Nerve or to the Muscle. — I do not know that the Nervous Power fails sooner than the Inherent of Haller.

That there is a Sameness of Matter in the whole Nervous System is pretty generally allowed, the only doubt is whether there be this sameness in the Muscles. It is the same in these too probably, & only different from a difference of Organization. Haller



Haller says they are not the same because they subsist independant of each other, & we say it is true & applicable to this effect, viz, of refuting the Stahlion system. We may suppose that ordinarily the inherent power may depend on the brain, yet it is possible that it may not require such a constant influx of matter as not to subsist sometime without communication. When a Muscle has been cut out of the Body with a portion of Nerve adhering to it, the Nervous power is still subsisting; but experiments on the nerve are liable to fallacy - At first pinching the nerve excites Contractions, but if the trial be repeated it does not answer, because the nerve is bruised; but this bruised part being cut off, the experiment on the fresh portions succeeded as before.

From the same effect of the same substances applied to Muscles and nerves, we conclude a sameness of Matter, & from their being Organs of Sense & Action there is a proof of the Continuity of Matter - There is no Argument from the difference of Sensation or Motion, since these only inferr a difference of Organization.

A question may here arise how far the inherent is dependant on the Animal & Nervous Powers?

**LXXVIII.** It seems to have a dependance - Let us see how far it can be supported - The



The Influence of the Animal power is manifestly considerable - Most Muscles are moved by the power of the Will - whether you will call it volition, there is not a muscle but what is to be operated upon by passions of the mind, and hence we conclude that the inherent power is constantly operated upon by a Function that we have supposed to be exercised in the Brain.

The next question that arises is, how far there may be a constant influx of this Nervous power, or whether, with Gaubius, it be fugax - And how often this renewal is necessary, and how long it may subsist without such? - When a Stimulus is applied to a muscle, whether it can be excited independant of any Influx? - There is a constant dependance of the Inherent power on the Animal, because the destroying the Nerves of the part immediately produce a palsy.

Morgagni has found that in consequence of cutting the 8<sup>th</sup> pair of Nerves, the Stomach became paralytic and did not do its duty.

Haller finds the same.

This single fact of a Palsy inclined with regard to the Stomach & that immediately & suddenly, proves to a demonstration that the Inherent power does not subsist with due vigor long after the Animal power is



is cut off. The passions, as fear &c., weaken (not to say render paralytic) every Fibre in the body - and this in different degrees according to the Passions applied.

The proof on the other hand of the independant power of the Inherent power, are these I have so oft mentioned, as the cutting out of muscles & their remaining even then subject to the power of Stimuli. We must grant it, but the question is how long it may subsist? and in what vigor it does subsist? - I find it difficult to answer this, and find that in Animals of cold blood it can subsist for many days, & possibly would longer were it not for being in a different Temperature, concretizing the Juices, & the like.

This question can only be properly determined by examining how long, in living bodies, these circumstances may subsist, without connection with the brain; and here we have been told that it subsists longer than in parts out of the body. Dr. Haller found that on tying a large Nerve it brought on Inflammation, Suppuration &c. - In one case an Animal lived with a large Nerve tied, with the parts below the ligature retaining their Inherent power, for 20 days: How much longer this Animal subsisted he cannot tell, as it ran away -

H



It subsisted thus independant of a communication with the Animal fluids.

It is well known that men live long with Paralytic members, no ways under the Influence of the will - All communication in this case with the Animal power is cut off - Still the Irritability is not entirely destroyed, as it may be excited by the power of Electricity.

These facts however do not admit the Conclusion I am drawing from them so evidently as I could wish. Paralytic affections are often partial, hence the Interruption may be partial so far indeed as to destroy the effect of motion but not of the Influence of particular Stimuli applied. From the case of paralytic affections no particular circumstances arise. - From the direct Experiments spoke of the Inherent power subsisted sometimes 20 days independant of the Animal power. This may be applied to different Theories, which we at present avoid. - In what condition does it subsist? Always considerably weakened. - Let a Palsy be very partial it weakens the powers so far as not to be excitable by common means.

A strong presumption arises to the same purpose from this view of the System, that these Functions are



are of universal Influence and support with regard to one another, and that there is a power in the Brain always diffusing its influence over other parts of the Nervous System.

With regard to the Theories of muscular Contraction, it is much easier to pull down than to build up.

**LXXIX.** Many Theories have taken in this. — Many have supposed that Muscular fibres are continuations of the Arteries; but these have no foundation — It is true that there are Experiments from Ligatures made on Arteries that the Muscles became paralytic, these were made on the Aorta or large Arteries, but the Experiment has been diversified without Palsy till the Stagnation had produced Mortification.

Besides the force of Arterial Blood in such small vessels is altogether unequal to such force of Muscles. — Many Animals too have no red Blood, and yet have very active Muscles.

Take a Frog & you may have most certain proof that after the heart is cut out, it will leap about many hours after the circulation has ceased.

At the same time the Blood is distributed to the Muscles, & it has some share in its functions, some conditions necessary to their office. — Heat cannot subsist,



subsist long without it, & the Muscles can't contract unless surrounded with fluid parts - But from what has been said you will say any Theory that the Motion of the Blood is immediately concerned in is false.

LXXX. This however has entered pretty generally into Theories, that Fluid is poured into these vesicles & inflates them to a Spherical figure.

But this will not account for the degree of Contraction in muscular fibres, as we see in a Polypus which contracts to  $\frac{1}{12}$ , whereas no management will make a vesicle contract to more than  $\frac{1}{3}$ , and the latest Observations have represented the muscular fibres uniform in their whole length, so that it is not agreeable to Microscopic Observation, nor at all applicable to account for the degree or velocity with which muscular Contraction takes place.

We are now come to the Theory of muscular Motion, in which so many attempts have been made and hitherto without success. None of them are satisfactory, & many of them so trifling as not to deserve attention, but I shall consider them all as there are very few Hypotheses that have not brought out facts to be met with<sup>no</sup> else where.

With a few words I have discussed two in LXXIX & LXXX



LXXX Paragraphs; for a more full discussion I refer you to Dr. Haller, and now I must say again that after pulling down we have no plan or materials to build it up again - but Physiological enquiries must still go on, tho' there is no prospect of immediately bringing them to perfection. If the darkness with which Physiology was involved 100 years ago had been on that account neglected, we should not have been on such good grounds as at present with respect to practice.

In LXXXI. I have endeavoured to come as near as possible: Here is a fact which if well supported will have considerable influence, but it has not been hitherto taken notice of - I offered this as a fact, but as a fact of which I am not conscious from my own Experiments or those I have had access to. The Stahlîans maintained it, but I don't know they ascertain it from any Experiment - Dr. Haller treats of it more fully in P. 565 of Tom. IV. I don't know how the Experiment is exactly made or what care is taken to avoid fallacy, marking the difference which arises merely from the vis vitalis. - With regard to other Elastics we know they will at one time sustain a greater weight than at another time, from being in different circumstances, - as in the case of Silk threads,  
being



being twisted or not.

From a gross observation of the Stahlins & others of Borelli, upon which Dr. Haller depends, & the evident weakness of dead muscular fibres we shall perceive how much they are plainly weaker than when alive. When alive they exert a force equal to 1000 lb weight. When I lift a pound weight suspended at the end of my finger, the force exerted by the Deltoid muscle is well known from exact Mathematical calculations to be 1000 times greater than that of the weight. I take the instance too of a noted strong man that lifted a table of 50 lb. weight with his jaw; the force exerted here was so immense that a tenth part of it would have torn our (dead) solids asunder. In the dead body the force of Tendons & Ligaments is infinitely superior to the muscular force, but in living bodies the muscles often break their Tendons.

Hence the conjecture of Dr. Haller is highly probable that the coherent force of the living fibre of muscles is greater than in dead ones - hence the nervous power must increase the vis coherens of simple solids or muscular fibres taken as such.

But neither in his small nor large work is he sufficiently accurate on the subject. - The Argument  
on



on the whole is not without its doubts; but as I am not intent on any one ~~opinion~~, I have taken the less trouble to resolve them.

The *vis Insita* of which Dr. Haller speaks when he calls it the *Alacrior Attractio*, you know he has maintained to be totally different from the *vis Nervo*a, and that the Nervous Influence is only a Stimulus, & has given you an influence of the same nature ~~in~~ Electricity, which some have supposed to be the same as in the Nerves; but this he has been at pains to refute.

But after what I have said about the same ~~ness~~ of the Nervous & Inherent power, & that it is a matter communicated from the one to the other, it renders it probable that the Animal & Nervous powers act upon the *vis Insita* merely by increasing its power.

Haller calls it a *vis Accessoria*.

Another fact I shall observe, if I bend my Arm by the assistance of the other, the *Biceps* will be contracted, but I shall find it a little increased in bulk in the middle, but it is still soft & not hard as if I had lifted it by the will. We then consider the hardness as a mark of the Force by which it is contracted. — The Contraction may be without this hardness.



It is the Nervous Influence directed by the will that gives this hardness & looks like Influa - But this is very fallacious, for suppose the Nerve were cut thro' & hence all Communication with the Animal power destroyed, the same contraction will take place with the same circumstances - And if a Stimulus be applied the hardness will take place, does the Stimulus introduce new matter? we have no evidence of it - It may act in some other matter, by exciting the activity of the Inherent power.

It is by no means certain that the Nervous power acts by Influa or giving an addition; somehow or other it can excite a motion. Even the Nervous power consists rather in motion than in any sensible Influa or addition of matter. - For when a Muscle is cut out of the Body & is excited by Stimulus applied to the Nervous power, there is no difference in the contraction whether the Nerve be a foot long or the tenth of an Inch; the freshness of the extremity being given, the effects are the same.

Now what effect this view of the fact will have on different Theories, I am not concerned about - Let what will become of Theory facts should be ascertained.

If it is true that the force or power of contraction consists in the increased cohesion of the fibre it will explain



plain why the action of the fibre is greater in the muscular than in other parts of the nervous system. Haller from this circumstance makes an objection against the muscular fibres being a continuation of the nervous, but the difficulty is in some measure removed if we suppose the muscular fibres as continuation of the nerves are under such peculiar circumstances as admit of contraction. The medullary fibre is soft & void of solidity, and as we find that an increased force of cohesion takes place in muscles we can account for this difference of function from the different conditions of the medullary and muscular fibres; the increase of the power of cohesion may appear so greatly different from that of the brain from a difference of organization.

**LXXXII.** That muscular fibres have a constant tendency to contract is evident, and this function is peculiar to muscles, the contractility is immediately perceived on cutting away a muscle from its extremity in consequence of which this disposition takes place, and is what I have denominated



denominated their tonic power. The Stahlians have employed it not only to the Muscular fibre but to Parenchyma or substance of the simple solids, and many others have also been inaccurate in employing it for the simple solid & muscular fibres indiscriminately. Others have likewise abused the term by applying it to the extension of Joints by Antagonist Muscles, as when I push against any substance with my Arm extended it is by means of this Tonic power of the Muscles. It has likewise been improperly used to express the state of Spasm, but I confine it merely to the inherent power in the muscular fibres independant of any *vis Accessoria* and tendency to contraction.

I should not have separated the two paragraphs **LXXXII** & **LXXXIII**, but otherwise it will come to no other than the Contractile power in general. There may be also a further contraction by means of Stimulus or of the Nervous power.

- The tonic power consists of two others
1. The contraction of Muscular fibres as <sup>simple</sup> solids.
  2. As possessed of the Inherent power.

The contraction of the Simple Solid will be as its degree of tension, i.e. in the extension of the fibre

the



the farther you stretch it the more force it requires. If a weight of one pound will extend a fibre one inch it will require a weight equal to 3 pounds to extend it 2 inches, therefore the force of contraction is as the degree of extension.

The inherent power depends also on Extension. Extension is a stimulus acting in the manner we have just now explained, by increasing the natural power of cohesion, hence the inherent power will be increased by extension, & it is very probable that the inherent power constantly acts & is excited by extension which is such a powerful stimulus.

**LXXXIV.** This paragraph is to shew that they are kept in extension by a variety of causes.

There are few parts in the body that have not motions in opposite directions & have muscles that balance each other called Antagonists - they are possibly brought into this state by the growth of the bones. This antagonist force is however not exactly balanced, for the flexors are stronger than the extensors, hence the extension is not by the force of the muscles alone but also by the weight of the part - take for instance the lower Jaw - The Jaw is constantly sustained by the levators



levators against its own natural weight, and in sleep when the Animal & inherent power are taken off, the jaw falls, & the weight of the parts has a share in keeping the Muscular fibres stretched, the same likewise in other parts on conditional occasions.

3. By fluids distending the cavities they surround. This takes place in almost every cavity of the body, & the power of the fluids is the most distinguished of any in the body, Volition excepted. In the Lungs after an Animal has once breathed the Air is not thrown out entirely, & these Organs are never in their most collapsed state. - Other parts are not so steady being subject to more unequal distension, as the Alimentary Canal, which nevertheless is however possibly never in a sound Animal in its most contracted state but always more or less of the Indigested fluids remain - or where this fails it would seem that Nature had assigned a quantity of Air for a greater or less distension of the Alimentary tube. The cellular texture manifestly shews an extended state, contraction taking place on division. It is kept in an extended state by the Air diffused in its



it's cavities, and in parts that are destitute of this by exhaling fluids. It may perhaps be extended by Flatus, & this flatus, secreted by exhaling fluids, gives it it's Elasticity, & in many cases an Elastic Air is present. Where there is no distribution of large blood vessels &c. Nature has been very provident in diffusing Air or other subtile fluids, as in insects &c., how far Air may have this effect I would not determine, but Senac says there is no portion of recent membrane but you can make to exhibit air or halitus, and his Observations seem pretty well confirmed by Experiment.

We can much easier declare what Muscular Motion is not than what it is. The last I have not attempted but mentioned some considerations that sh<sup>d</sup> be attended to in attempting a subject of such importance & of such difficult investigation.

Tho' we do not understand the Theory of Muscular Motion, yet we may understand several circumstances that determine it's motion. - There is some power constantly acting on our Muscular fibres that gives them a tendency to contraction in an extended state, and this I call their Tonic power. Muscular fibres are simple Solids of a natural Elasticity, hence their tonic power must in part depend



depend upon their being simple Solids, possessing Contractility in common with other Elastics; this is in proportion to their Tension - to this is superadded their inherent power, but how far this is connected with their tension is not so evident. The *vis Inrita*, if it be with Dr. Haller a natural increase of Contractility, we may suppose that it will follow in proportion to the tension. As the extension alone proves a Stimulus to this inherent power we conclude that it is always by encreasing the tonic power. This tonic power *ceteris paribus* will be in proportion to the degree of Tension under which the fibres are, Nature has industriously provided to put every Animal fibre in a state of Tension.

I have endeavoured to enumerate them - the 3 first I have spoken of, & added in the 4<sup>th</sup> place by their connection with distending blood vessels. Nature has provided a mixture of the blood vessels with the sentient extremities of the Nerves, and when these blood vessels are in an inflamed state the sentient extremities become more sensible. The blood vessels can only act by stretching out the Nerves in Inflamm<sup>n</sup>. Tho' in a less degree yet



yet by constantly operating I imagine the same distension of blood vessels has an effect in giving tension to the Muscular fibres connected with them. In every Muscle we see these blood vessels are under a particular Arrangement, but what it is Anatomists have not yet pointed out, but Nature has industriously mixed the blood vessels with the Muscular fibres, & tho' they may not always be red vessels, serous or even vessels subordinate to these may perform the office. It is probable this has an effect from an Aphorism of Sanctories [quod pondus addit robur] that the body is stronger as it is more filled with fluids. If we employ bleeding, the muscles become weak and relaxed, and we likewise induce considerable debility from a topical Evacuation; hence we may fairly conclude that their connection with such distended cavities is another cause of Tension. In some Animals as those of the Insect kind that don't seem provided with an Arterial System Nature has provided another structure, having every where dispersed air vessels surrounding their muscles & supporting their structure as in the blood vessels of other Animals. Perhaps to all this I should have added external pressure, which  
in



in many instances seems to have effect on muscular fibres, but I do not insert it in my text, for I can see that it is more an addition to the tonic power than to the tension, being plainly a support to prevent a further tension by distending fluids. Baths cloaths &c have considerable influence on our bodies & on Muscular Fibres.

LXXXV. I will not repeat the Arguments for the dependance of the inherent on the Animal & Nervous powers; as soon as any connection with the Animal power is cut off, a palsy is induced.

This Animal power (whether dependant on the Mind in certain cases) may be increased or diminished by various means, & therefore the Tonic power must be in some measure in proportion to the Animal - hence the tonic power is

1. In proportion to the Contraction of the simple solids.
2. As it may depend on the inherent power.
3. In proportion to the Animal power.

It will be hence sufficiently obvious that Tonic power will not be simply as the degree of Tension, neither must they be taken or compounded together.



- take a chord of Hemp and a piece of Catgut & extend them to the same fixed points - the power necessary for this will be very different, & when removed the Elasticity will be with a different tone, & a different contractility in these cases, hence if tonic power differs in inanimate fibres, it must do so in the animate; hence too if the tonic power be increased it would be very improper to call it an increase of Tension.

**LXXXVI.** The force of Contraction is to be distinguished from the facility of Contraction, & this is a necessary distinction - it depends in the first place on Stimulus as a cause of Motion.

Whatever Theory we adopt it must operate by exciting motion, no matter whether it be an impelling force or a peculiar matter in the subject excited, it is all one, there is still a force of Stimulus, & hence if the facility of the Animal & inherent power be given it will be as the force of Stimulus.

Thus I would first consider Stimulus as a cause of motion purely Mechanical, Stimulus acting then on the inherent power as independant of the



the Animal; but when it acts on the brain by a peculiar modification it is more increased than we can suppose, by simple mechanical impulse.

2. It is as the force of Stimulus, inherent & Animal powers taken together, it is in the exertion of the Animal power we observe the utmost exertion of force & strength of contraction - what they more especially depend on must be a matter of after consideration. However we observe a strong contraction take place, it is to be referred to the force of Stimulus or to it's powers inherent or Animal.

We must begin first with general circumstances and descend to particulars.

LXXXVII. Here I again enter on a subject the most difficult, I before observed, of any in Physiology or Pathology, hence I mark with caution, the expression it seems. I shall have occasion to mention hereafter other mobilities of the System in general, as in particular parts -  
When a Man, for instance, has been riding a  
Hard



hard mouthed horse, if immediately after he dismounts he endeavours to write, a tremor will come on. It is the same with regard to the use of most Instruments, a certain weight is necessary for firmness, steadiness, & due Tension. It is easy to prove that the taking off Tension, as the emptying the blood vessels, does act on particular parts, giving mobility, tremors &c. discovered in every motion. I must add here what I in some measure made a part of the tonic power, viz, external pressure & sustentacula, which in many cases determines the degree of pressure to various actions, hence the taking off ligatures have this effect, & one case to this purpose is related by Van Swieten of a Lady who was obliged to be kept in swaddling cloaths.

Mobility and Strengh are opposite circumstances & conditions of the System as Mobility alwise arises from weakening the Animal powers which cannot be explained but by this mobility affecting the whole System. — I go on to point out a particular application, but like the proposition it is founded upon it can only be generally enunciated.



**LXXXVIII.** We have an example of such a case plainly before us. In the blood vessels I think the tension depends more on the Tonic than on the Animal powers. In the Alimentary canal the Tension is extremely unequal - no part of the system is more liable to be affected by changes of the Animal power by reason of the number of Nerves employed in the functions of that Organ, and from all this we conclude that their tonic power depends more on the Animal power than on the precise degree of Tension.

**LXXXIX.** This I mean to speak of as a fact only abstracted from any Theory, & the proof is given in **XC.** In the straight Muscles of dying Animals & in those recently dead we observe Contraction taking place & alternating with extension. But this is more commonly observed in the Heart. Whatever may be the exciting cause it is not a single contraction that is produced but many alternate contractions, how this is produced I do not say, but it takes place even when the stimulus is constantly applied. When the Heart has ceased to contract on the application of a needle



needle, it will undergo the alternate states of contraction & relaxation altho' the needle be still fixed in it - here then is something in Muscular fibres whch disposes them to alternate with relaxation, & this is a property of Muscular fibres.

Haller has endeavoured to point out that it is only in certain Muscular fibres, & does not exist, he says in the Vesica Urinae nor in Arteries, as for instance when the Vesica Urinae is distended if you touch it, it goes on uniformly to contract, but after that it does not extend & contract, alternately as in other muscles. - This may however depend on circumstances extraneous to the Muscular Fibres themselves, as when a muscle is in a circle it can't overcome the resistance & consequently cannot be put into extension - but take a portion of the Urinary bladder so as not to be influenced by the neighbouring parts, and it will shew the same phenomena as other muscles. This should also be tried in a small portion of an Artery with respect to it's irritability, and from the whole of



of the circumstances taken together I conclude them to be of the same nature with Muscular fibres.

XCI. I just now for instance bend my Arm in consequence of which I find my Biceps shortened, but if an external force be applied to support it I relax the will & hence the muscle becomes flaccid & soft tho' as much contracted as before. The fibres tho' not extended may fall into a relaxed state, this is the case of the Heart in it's Perisystole; it is easily explained in this way after it's contraction it falls into the same state of relaxation as when I have withdrawn the power of the will from my Biceps - again I have observed that the powers that dilate the heart exert a force greatly inferior to what it excites in the contraction - in simple Elastics it is far otherwise.

As a relaxation is induced by extension it is in many cases difficult to say when or how long it is in the power of the will to keep the muscles in a contracted state, we find this power of the will to be very limited - It would



would seem that the disposition to contract, is either in the Animal power itself or in the nature of the fibre. I now go on to insert, two pathological definitions.

XCII. Certain Convulsions may be so defined, but it does not take in the whole of Convulsion to constitute it.

Certain protracted action of the Animal powers are examples of preternatural causes, these producing contraction in an unusual degree give convulsive motion, whatever is the circumstance or condition of their contraction. In the vital we may say it is not so when it is by a preternatural cause. The power of habit determines our force & velocity of contraction, if either of these be more than usual all Physicians call it a Convulsive motion - to constitute a Convulsion it is not necessary (for instance) that the Subs. Tendin. sh<sup>d</sup> be often repeated, one single Subcullus is sufficient.

We cannot always perceive the cause & power, hence cannot always mark this as a characteristic of Convulsion, when it operates in the heart, the cause is an influx of the



the venous blood. It may be by a stimulus in this blood or it may be by the animal power, we can't always perceive these & hence must apply to those in the manner of contraction. With regard to the manner of contraction of most muscles, those governed by the Will are the most invariable, they have a determined force & velocity ~~which~~ is usually exerted, when we see a change in the force or velocity we denominate it Convulsion, & this part of our definition shews that Convulsion may take place in a simple (unusual) contraction, thus Hiccups is a convulsion of the Diaphragm tho' occurring but once, but it is especially so if occurring with unusual velocity & force &c, & it is then we particularly denominate the motion convulsive.

**XCIII.** As being with unusual velocity & force Spasm may agree with convulsion, but Convulsion still admits of muscular relaxation, whereas Spasm differs in it's not spontaneously alternating with relaxation. I have endeavoured to shew that every Muscle has it's Peristole, it's state of relaxation depending on



on the will; thus the Biceps after being shortened by the power of the will becomes hard, but if this power of the will be taken off it becomes flaccid. We don't observe this in Spasm, but in a much longer interval which is a proof that it is not ready to yield to the will, nor even to considerable extending powers applied, nor to antagonist muscles. In Spasm the Contraction is in the greatest degree of velocity & force whence the hardness so constantly concomitant with the Spasmodic state.

But the most remarkable characteristic is that it is not disposed to alternate with relaxation, this however we can't explain till we know something more of the nature of Muscular fibres. There has been much ambiguity in the use of these terms among Physicians; the Antients comprehended the terms of Spasm & Convulsion under one, & indeed the abuse of this yet prevails as Spasm is often used in the proper sense of Convulsions, nor is it enough to avoid confusion that we do not use them together, we ought surely to



to have different terms for these two different species of Convulsions. After having been used so generally it may be thought wrong to confine them, but there is a necessity for it. We now come to two other circumstances with regard to Muscular fibres.

XCIV. Perhaps I sh.<sup>d</sup> have added that Muscular Contractions tho' not exerted with unusual force become uneasy & weaker on being long exercised, nothing is more evident than that Muscles can become fatigued, the fact is so common that it might seem unnecessary to mention it, but we shall find a particular application for it, it is necessary to contract it with what follows. For these may induce weakness that may subsist even for life, but if with the due degree of interval their motions are performed with more facility & exerted with more force every one perceives that actions wh are at first performed with difficulty by repetition become easy, & there are sufficient instances of this in every human Art, what concerns us especially is that the same takes place with regard to internal motions, as in vomiting, thus g.<sup>m</sup> V of Tart. Emet. that at first will perhaps be necessary  
to



to make a Man vomit, will by repetition have this evacuation excited by  $g\frac{r}{s}$ . It is the same with regard to the intestines, such motions too in consequence of their being repeated become as it were spontaneous - the particular laws with respect to the periodical motions of the System I refer to another place. This is the reason why many diseases return by the power of habit alone, as in Epilepsies, Intermittents, Chincough, &c being then excited by much slighter causes than would have first produced them.

A difficulty here arises, as we have before said that Impressions in consequence of repetition become weaker of which likewise there are innumerable instances in Physic where the dose must be increased in order to have it's usual effects. I shall here bring an instance from the same medicine before adduced. A person on whom  $g\frac{r}{s}$  of Tartar Emet. w<sup>d</sup> first operate will at length require  $g\frac{r}{v}$  to produce the same effect. It improves our active powers & diminishes our passive ones, it encreases action & diminishes sensibility; indeed I do not pretend to explain when the one law of Impression & when the one of facility takes place, but it is certain



certain that they are both laws very frequently operating & hence must be very principal in our Composition. As I said Actions by repetition are performed with more facility, so they are performed with more force & hence people become stronger by exertion. I don't know if the story of Montaigne is true with regard to a Man who first began to lift a calf, & by continually carrying it from time to time was at length able to lift it when it became an Ox - but we have many instances of persons by repeated exertions becoming stronger, e, g, the strong Man of Topham who at first was no stronger than others of his bulk & make, but by frequent exertions of his vigour attained to a degree of strength altogether astonishing. To this a quere is subjoined which arises from the 119 Par. of Haller's *Primo lineae*.

XCIV. Why the Heart contrary to other Muscles feels no lassitude is a difficult problem to resolve. I have hinted at a reason that it is the contraction produced by the Animal power that is more especially liable to become weak.

It is the action of voluntary motion in which therefore the Animal power is exerted & employed, when these Voluntary motions become spontaneous



neous they likewise get into the condition of the heart & may be used without fatigue, as in ordinary walking, talking &c. such the under the power of the Will yet go on with very little volition or consciousness, and hence when we only excite them to such a length as we have <sup>been</sup> accustomed to, it is with little difficulty or fatigue. The organs of respiration where motion is voluntary go on without fatigue night & day, not so frequent as the heart but attended however with no greater sense of lassitude. I might here have put the question whether this growing weak was an affection of the Muscle itself or of the Animal power? I cannot doubt but it is of the Muscle itself - in spite of that the Muscle will lose its mobility which makes me believe that Contractions are not only alternated with relaxations but also depend on the inherent power which is in the brain and is liable to considerable variations, & is necessarily determined to alternate its states of action with rest, & hence the reason that weariness arises in any part from being long exercised. The heart we believe has no occasion for the



the influence of the animal power every time  
of its contraction.



End of the first Volume.

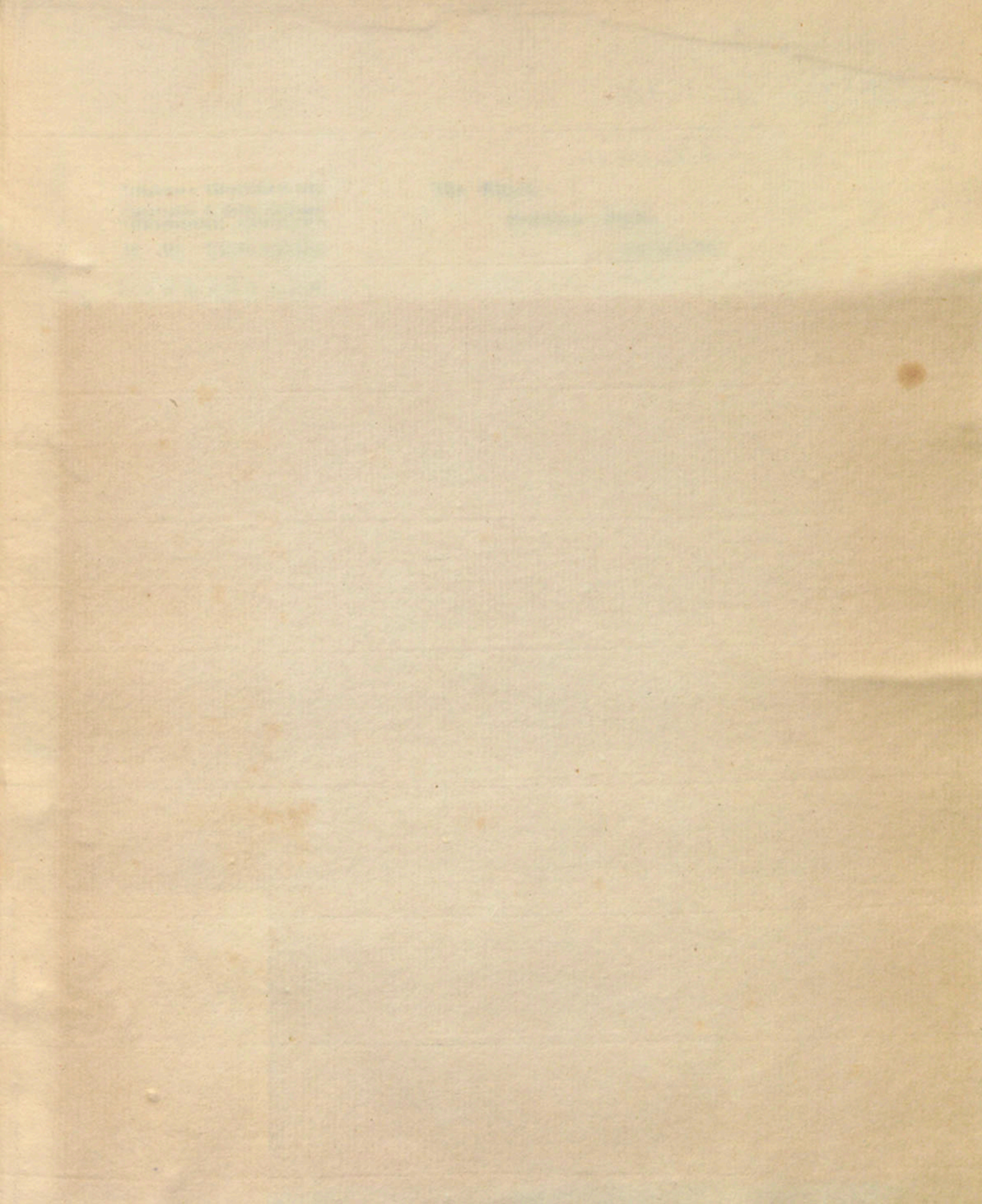














H. W. Edwards,

Cat. 35, Dec. 1948

\$25.00.

Accession no.	10815
Author	Cullen, William
	Lectures upon the institution of med.
Call no.	Vol. I 1768
	Manuscript
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